

- a) Glucose: C _____ H _____ O _____
 b) Fructose: C _____ H _____ O _____
 c) Galactose: C _____ H _____ O _____

3) What is one common thing shared by these three molecules? _____

4) What makes them different from each other? _____

5) These monosaccharide molecules can be used to make a more complex sugar, called a disaccharide. Before this can happen, one of the molecules must lose a hydrogen atom while the other must lose a hydrogen atom and an oxygen atom. Why is this important?

6) If we combine this H and OH, what simple substance does it form? _____

7) When the two monosaccharides are put together to form one disaccharide, how many water molecules were formed? _____

8) This process is called _____ synthesis because of the loss of water while the reaction is taking place.

9) Examine the three paper molecules on the last page. They represent a monosaccharide. Cut them out along their outer lines. Try to put them together so that if they are moved, they will remain attached.

10) Is there any way for them to remain attached to each other? (In other words, if this was a puzzle, would the puzzle fit together properly) _____ Why not? _____

11) Now, cut out an H from one of the molecules and an OH from another one. This leaves a hole on one end of the model and a piece sticking out of the end of the other model. Join the two monosaccharides together. What do they now form?

12) Join the H and the OH. What molecule does it form? _____

13) Now add a third monosaccharide to the two you have already formed. What must be done in order for the third sugar to be added? _____

14) This molecule containing all three monosaccharides is called a _____

15) How many water molecules were removed when the three-molecule polysaccharide was formed?

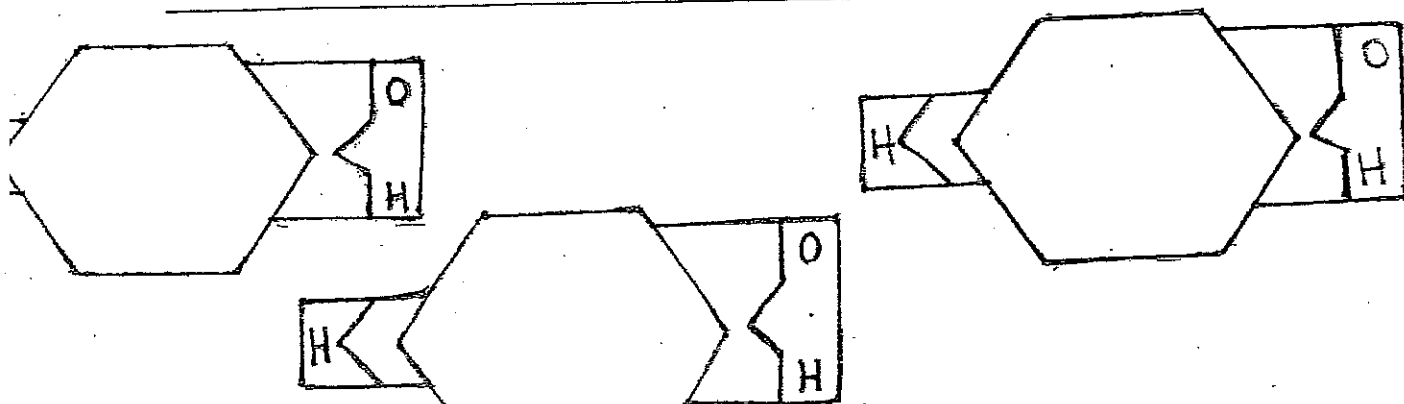
16) Fill in the blanks:

- When I join two monosaccharides, I need to remove _____ water molecules.
- When I join three monosaccharides, I need to remove _____ water molecules.
- When I join fifty-three monosaccharides, I need to remove _____ water molecules.

17) Following the logic in #16, write a simple rule that will tell a person how many water molecules will be lost while putting together any number of monosaccharides together to make a polysaccharide. _____

18) The process that destroys molecules into their monomers is called _____

19) Explain how this process works on a polysaccharide. _____



20) Look at the molecules at the bottom on the previous page. After they go through dehydration synthesis, what do they look like? Draw them in the following space.

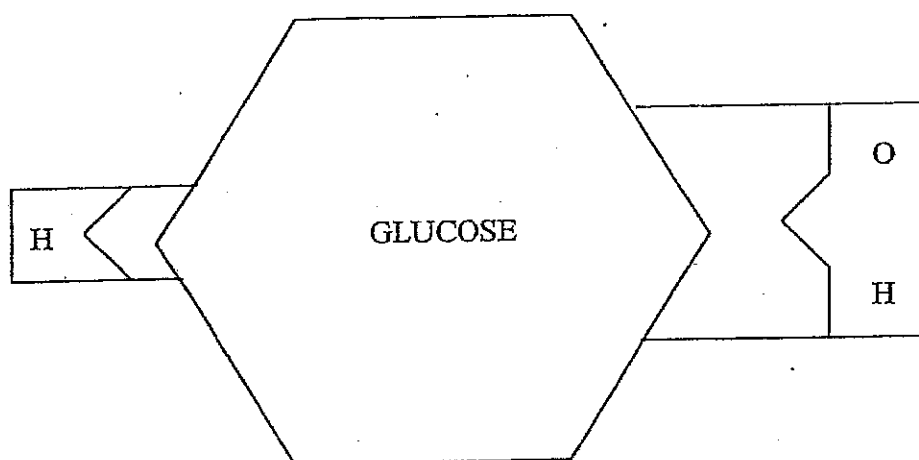
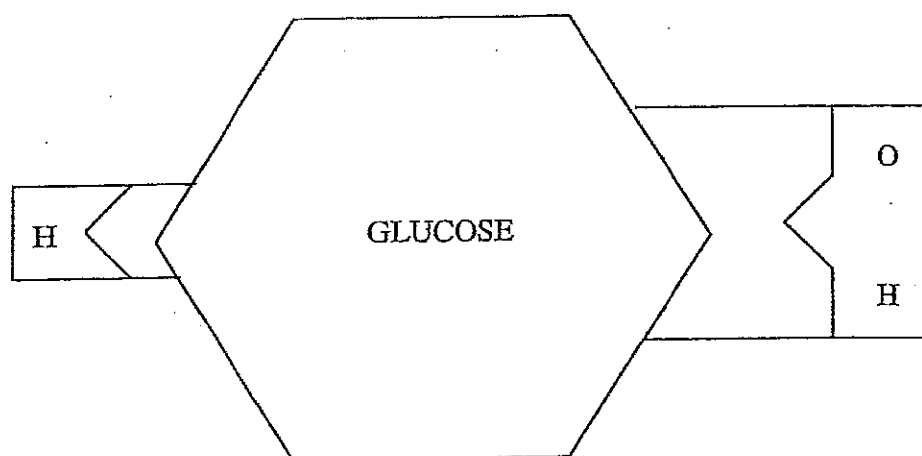
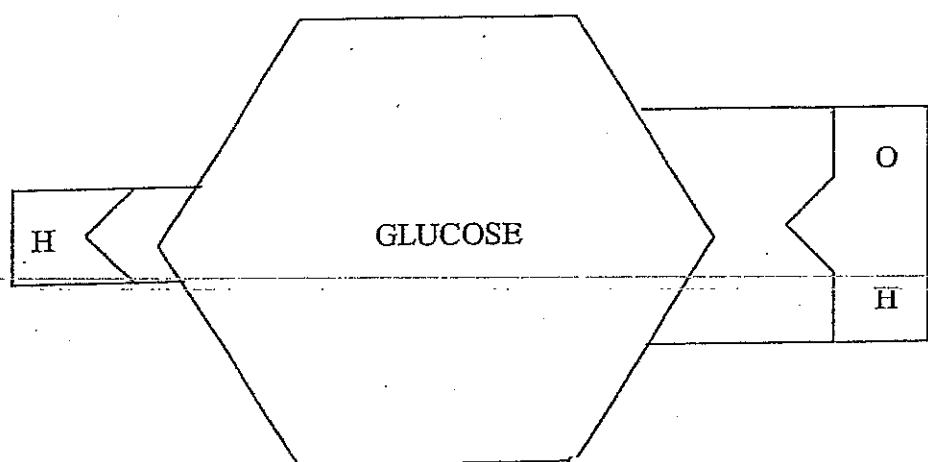
21) Now, take this new molecule and look at it. What will this new molecule look like after it goes through hydrolysis? Draw this in the following space.

22) Write three things that you learned in this lab:

a.

b.

c.



Cell Energy

13

Energy within a cell exists in the form of chemical energy. A source of this chemical energy is a compound called adenosine triphosphate (ATP). ATP when changed to a compound called adenosine diphosphate (ADP) releases energy for biological work in a cell. ADP can be changed to ATP, but this reaction requires energy. During cell respiration, energy made available from the breakdown of glucose is used to change ADP to ATP.

In this investigation, you will

- use paper models to construct molecules of adenosine triphosphate (ATP) and adenosine diphosphate (ADP).
- determine similarities and differences between ATP and ADP.
- illustrate energy release when ATP is changed to ADP.
- study the ATP-ADP cycle.

Materials



tracing or typing paper
light cardboard (optional)

scissors
paste (optional)

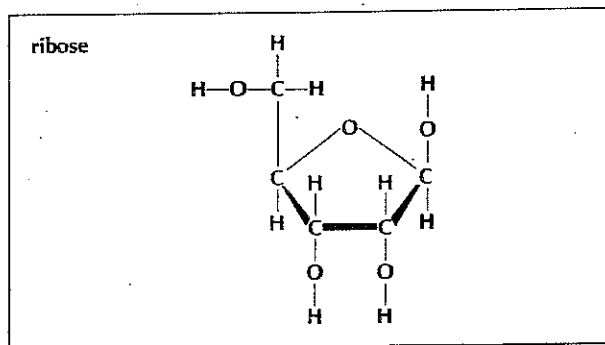
Procedure

Part A. The Chemical Structure of Adenosine Triphosphate

ATP is made up of smaller molecules or subunits—ribose, adenine, and phosphoric acid or phosphate groups.

Ribose Molecule

- Examine the structural formula of ribose.



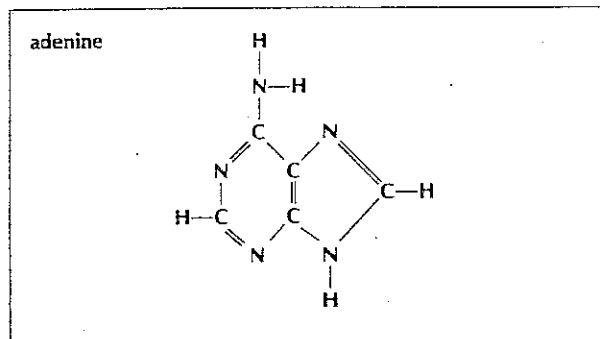
- What is the simple formula of ribose? (Fill in the appropriate subscripts.) C___H___O___
- How does the number of hydrogen atoms compare to the number of oxygen atoms in ribose? _____

Ribose is a carbohydrate. It is different from glucose in one very important way. Glucose has six atoms of carbon in each molecule.

- How many carbon atoms are in ribose? _____

Adenine Molecule

- Examine the structural formula of adenine.



- What is the simple formula of adenine? (Fill in the appropriate subscripts.) C___H___N___
- (a) What element is in adenine that is not in carbohydrates? _____
(b) What element is in carbohydrates that is not in adenine? _____

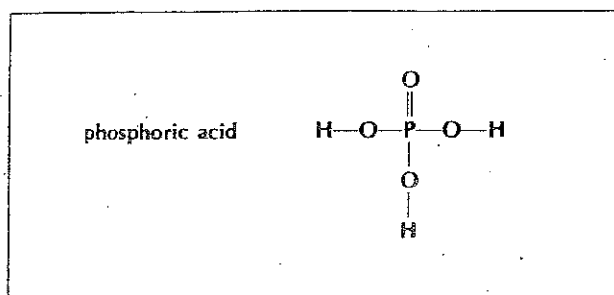
(c) What name is used to describe the H-N-H group? _____

(d) Is adenine an amino acid? _____

Phosphoric Acid

• Examine the structural formula of phosphoric acid. Phosphoric acid is much like the phosphate groups in ATP.

NOTE: The letter P represents the element phosphorus.



6. What is the simple formula of phosphoric acid? (Fill in the appropriate subscripts.)

H__ P__ O__

Constructing an ATP Molecule

An ATP (adenosine triphosphate) molecule is made up of one ribose molecule, one adenine molecule, and three phosphate groups joined.

7. What does the prefix tri- in triphosphate mean? _____

8. Adenosine is a word made up of a combination of letters from two different words. Part of the word comes from ribose (the letters "os"). Where do the letters "aden" and "ine" come from? _____

• Trace the models in Figure 13-1 onto a separate piece of paper.

• Cut out the models of adenine, ribose, and phosphoric acid you just traced. **CAUTION:** Always be careful with scissors. You may want to paste the page on lightweight cardboard before cutting out the models. Cut along solid lines only.

• Attempt to join the adenine and ribose molecules much as you would pieces of a puzzle.

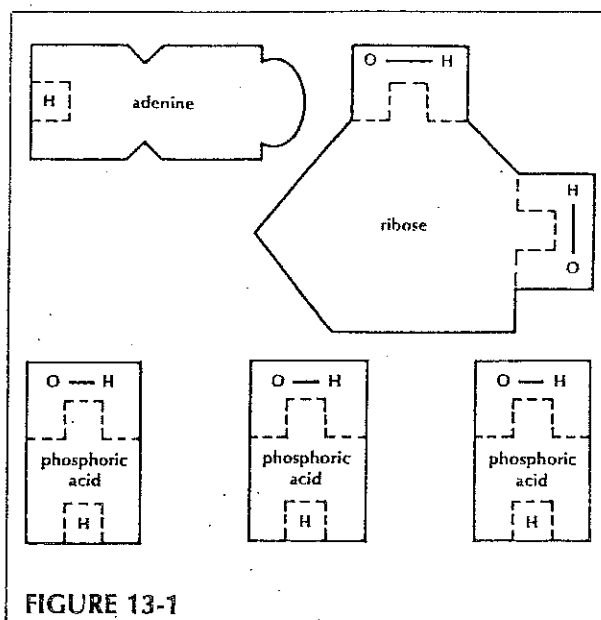


FIGURE 13-1

9. What end parts must first be removed from each molecule in order for adenine and ribose to fit together? _____

• Remove these parts. The adenine and ribose molecules can now be chemically joined. New points of attachment or chemical bonds are formed.

10. What molecule is formed from the parts that are removed? _____

• Examine the phosphoric acid models.

• Attach one of the three phosphates to the ribose molecule by removing an H from the phosphoric acid molecule.

• Attach the remaining phosphoric acid molecules one at a time to the phosphate group already attached to ribose.

11. What did you remove to make these connections? _____

You have now built an ATP molecule.

12. List the five "building blocks" that are needed to form one ATP molecule. _____

13. What is required for the chemical combination of these parts? (HINT: See introduction.) _____

Name _____

Date _____

Part B. Gaining Energy from ATP as It Changes to ADP

- Remove one phosphate group from the end of your ATP model.

14. How many phosphate groups are still attached to the original molecule? _____

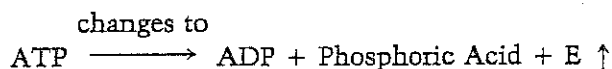
15. This new compound with one fewer phosphate groups than before is called adenosine diphosphate (ADP). What does the prefix di- mean? _____

16. List the four "building blocks" that are needed to form one ADP molecule. _____

17. Explain how an ATP molecule is changed to an ADP molecule. _____

18. What is released when ATP is changed to ADP? (HINT: See introduction.) _____

So far we have seen that ATP can be changed to ADP with energy given off. This change can be written using a type of shorthand. For example, this change may be written as follows:



19. What might the letter E in the above equation be an abbreviation for? _____

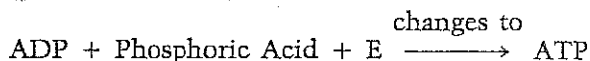
Part C. Changing ADP to ATP

ATP can be formed within living organisms if the correct raw materials are available. These raw materials are ADP, phosphoric acid, and energy. We can again use models to help show how ATP is formed.

- Construct an ADP molecule.

- Attach a phosphoric acid molecule to the ADP model. If necessary, remove any H or OH ends to provide the point of attachment. This combination forms an ATP molecule.

Energy is needed to change ADP back to ATP. Using a type of shorthand, this change can be written as follows:

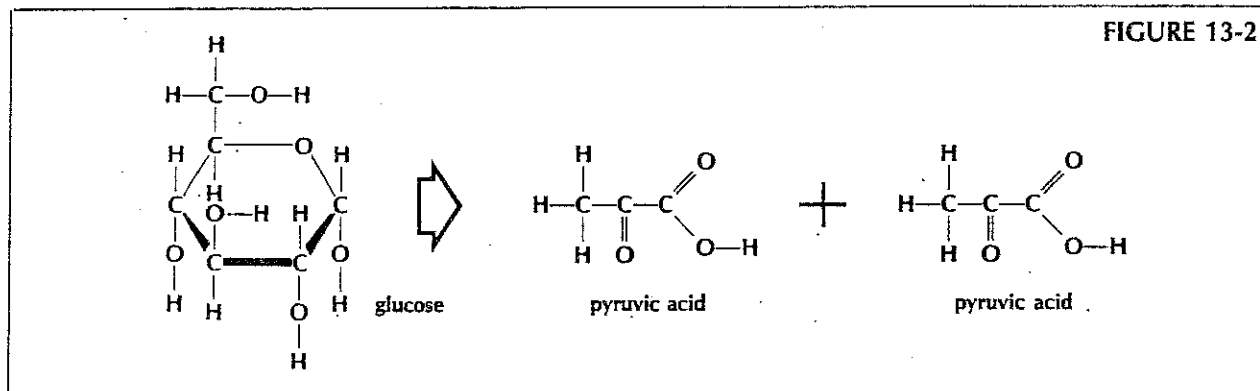


20. What might the letter E in the above equation be an abbreviation for? _____

Part D. An Energy Source for Converting ADP to ATP

From where does the energy to form ATP from ADP come? It does not come from the energy released when ATP changes to ADP. The energy comes from a different source. Energy is "stored" in all compounds. Food such as glucose contains much energy. Glucose is the major source of energy for ATP formation. Energy is released from food during cellular respiration.

- Examine the structural formula for glucose shown in Figure 13-2. In respiration, glucose is broken down into two identical molecules of a chemical called pyruvic acid. This step is called glycolysis ("glyco-" = glucose, "-lysis" = break apart). Glycolysis is the first step in cellular respiration (Figure 13-2).



The lines which connect one atom to another represent chemical bonds. (A double line like this // represents two bonds.)

21. Count and record the number of bonds in

(a) one molecule of glucose. _____

(b) two molecules of pyruvic acid. _____

NOTE: Be sure to count double lines as two bonds.

22. Is the amount of energy in one glucose molecule the same as the energy in both

pyruvic acid molecules? _____

23. How is some of this extra energy used? _____

Pyruvic acid is broken down further to yield more energy. Energy released from glucose during respiration is used in building more molecules of ATP.

Analysis

1. List the name and number of each molecule forming ATP. _____

2. List the name and number of each molecule forming ADP. _____

3. How do ADP and ATP differ in

(a) number of phosphate groups? _____

(b) number of ribose molecules? _____

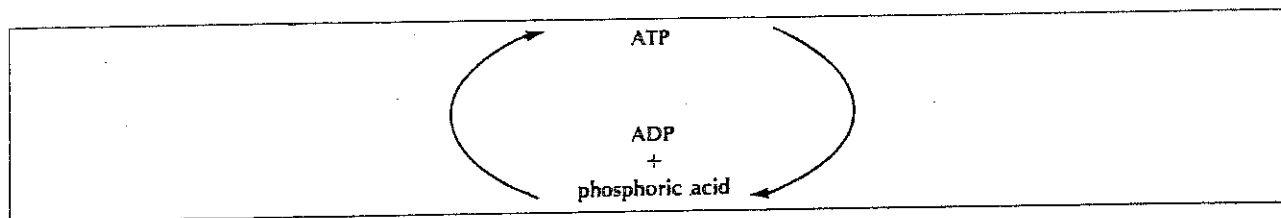
(c) number of adenine molecules? _____

(d) amount of potential chemical energy? _____

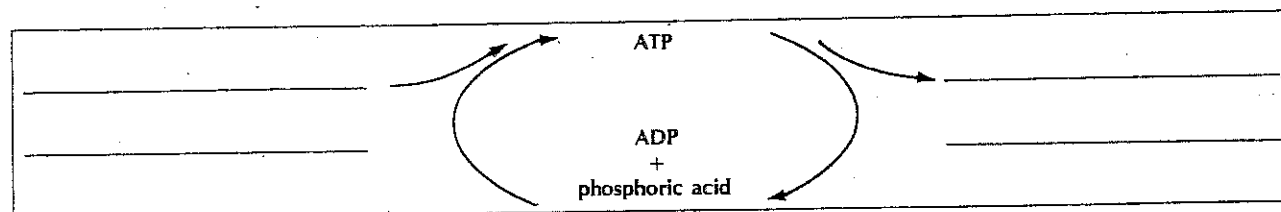
4. Your muscles require energy to move your body. What chemical directly supplies your muscles with energy? _____

5. What process directly supplies your body with the energy it needs to change ADP back to ATP? _____

6. Changes from ATP to ADP and back again are often said to occur in a cycle. One change follows the other in this manner:



Energy is both given off and used for work. Energy is also supplied during cellular respiration. Complete the diagram below by writing in the words "energy given off" and "energy supplied from respiration" in the correct spaces.



Name _____

Date _____

DNA And RNA

24

Deoxyribonucleic acid (DNA) is a complex molecule found in all living organisms. DNA is the chemical of which genes are composed. An understanding of the organization of this molecule has answered many questions. Scientists now know how chromosomes can duplicate during cell division and transfer their genetic information to new chromosomes. Scientists also understand how chromosomes in the cell nucleus can direct the formation of specific proteins outside the nucleus.

In this investigation, you will

- learn the names of the molecules which make up DNA.
- use models to construct a molecule of DNA and show how it replicates.
- learn the names of the molecules which make up RNA.
- use models to show how the base sequence code in DNA is transcribed exactly to RNA.

Materials



4 pages of paper models
scissors

NOTE: SAVE ALL MODEL PARTS. THEY WILL BE NEEDED FOR INVESTIGATION 25.

Procedure

Part A. Structure of DNA Nucleotides

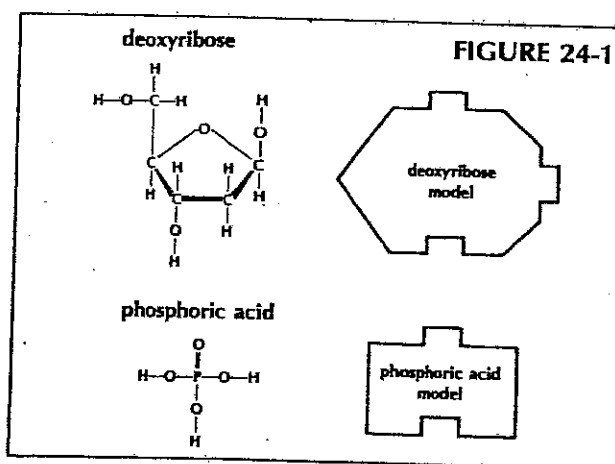
Two important molecules which make up DNA are deoxyribose and phosphoric acid. Their models and structural formulas are shown in Figure 24-1.

1. Give the simple formula for

(a) deoxyribose C___H___O___

(b) phosphoric acid H___P___O___

Deoxyribose is a carbohydrate. Phosphoric acid was studied previously as a molecule in ATP.



<p>guanine</p> <p>guanine model</p>	<p>adenine</p> <p>adenine model</p>
<p>thymine</p> <p>thymine model</p>	<p>cytosine</p> <p>cytosine model</p>

In addition, there are four different molecules called bases. Their structural formulas and models are shown on page 93.

2. Of the four bases, which other base does

(a) adenine most resemble in shape? _____

(b) thymine most resemble in shape? _____

A molecule of deoxyribose joins with phosphoric acid and any one of the four bases to form a chemical compound called a nucleotide. A nucleotide is named for the base that joins with the deoxyribose. For example, if thymine attaches to deoxyribose, the molecule is called a thymine nucleotide.

• Use the pages of nucleotide models to answer questions 3 and 4.

3. List the four different nucleotides. _____

4. (a) How is each nucleotide alike? _____

(b) How does each nucleotide differ? _____

Part B. Structure of a DNA Molecule

A DNA molecule is "ladderlike" in shape. Deoxyribose and phosphoric acid molecules join to form the sides or uprights of the ladder. Base molecules join to form the rungs of the ladder.

• Cut out the 24 nucleotide models provided by your teacher. *Cut only on solid lines. CAUTION: Always be careful when using scissors.*

• Fit six nucleotides together in puzzlelike fashion to form a row in the following sequence from top to bottom:

Cytosine nucleotide
Thymine nucleotide
Guanine nucleotide
Adenine nucleotide
Guanine nucleotide
Cytosine nucleotide

Let this arrangement represent the left half of a ladder molecule. It should consist of one side or upright plus six half rungs.

5. If DNA is "ladderlike," which two molecules of a nucleotide form the sides, or upright portion of the ladder? _____

6. To which molecule does each base attach? _____

7. Name the molecules of each nucleotide that form part of the ladder's rungs. _____

• Complete the right side of the DNA ladder by matching the bases of other nucleotides to form complete rungs. It may be necessary to turn molecules upside down in order to join certain base combinations. NOTE: The ends of each base will allow only a specifically shaped matching new base to fit exactly.

Your completed model should look like a ladder with matched bases as the rungs. Besides being shaped like a ladder, a DNA molecule is twisted. It looks like a spiral staircase. However, your paper model cannot show this shape.

8. Is the order of half-rung bases exactly the same from top to bottom of each side of your model? _____

9. Only two combinations of base pairings are possible for the rungs. Name these molecule combinations or pairs. _____

10. If four guanine bases appear in a DNA model, how many cytosine bases should there be? _____

11. Your DNA model has four guanine bases.
(a) Does the number of cytosine bases in your

model agree with your prediction? _____

(b) The following are the bases on the left side of a DNA molecule. List the bases that would make up the right side of a DNA molecule.

Thymine _____

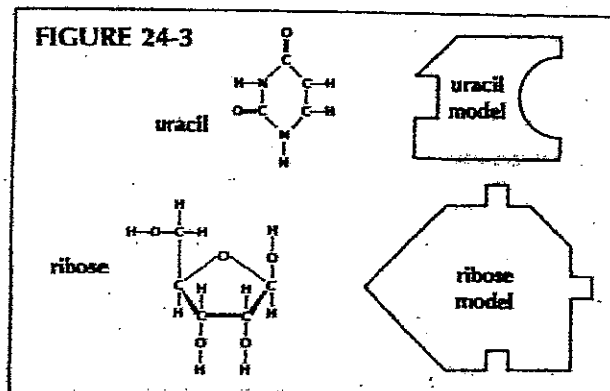
Adenine _____

Guanine _____

Guanine _____

Cytosine _____

Date _____



17. What is the code of a chromosome? _____

Part D. RNA Structure

Besides ensuring the exact replication of chromosomes, the sequence (order) and pairings of bases are a genetic code of the instructions for the entire cell. How does a cell "read" the chemical message coded in its DNA in the form of specific base sequences? Part of the answer lies with a second molecule in the nucleus of cells called ribonucleic acid (RNA).

RNA is similar to DNA in that its molecules are also formed from nucleotides. However, deoxyribose and thymine are not found in RNA. Two other molecules, ribose and uracil, are present. Ribose replaces deoxyribose, and uracil replaces thymine. Looking at their structural formulas and models, you will see certain similarities between the molecules that they replace. Formulas and models are shown in Figure 24-3.

18. (a) Which base is replaced in RNA by uracil?

(b) What chemical replaces deoxyribose in

RNA? _____

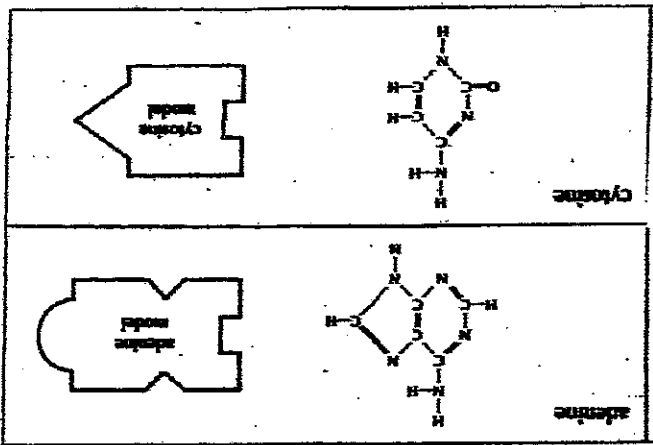
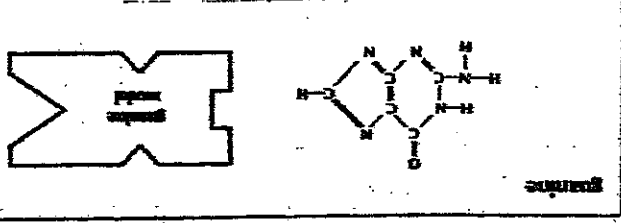
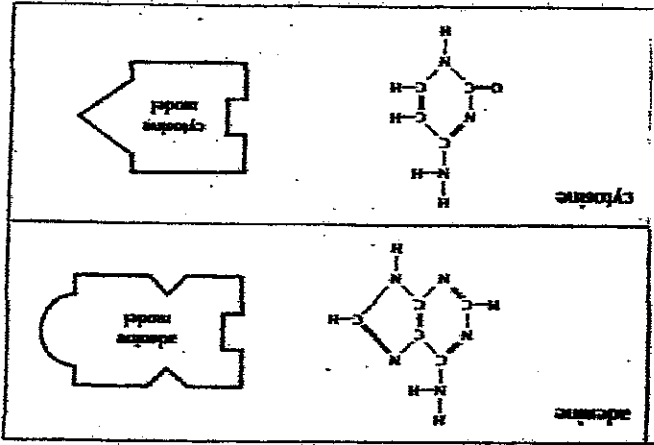
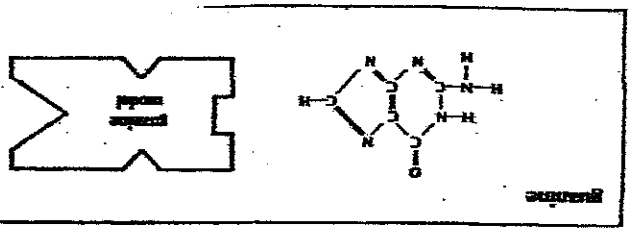
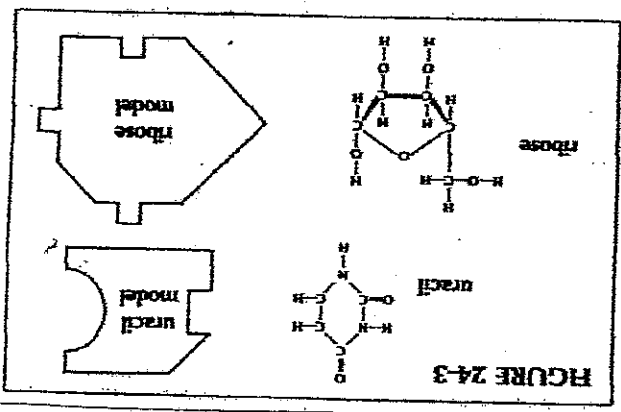
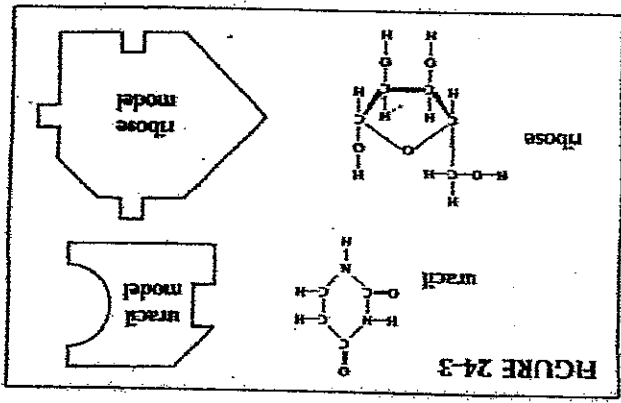
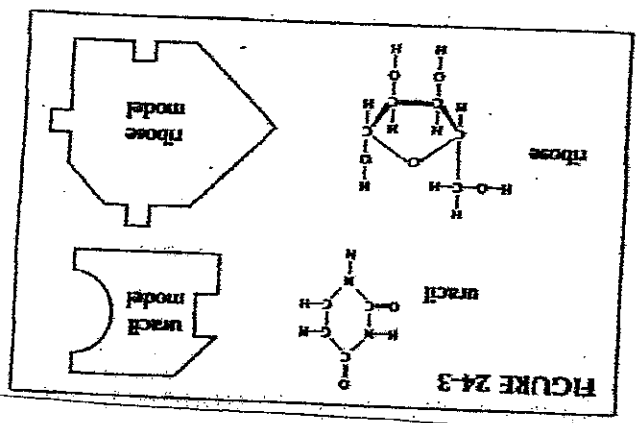
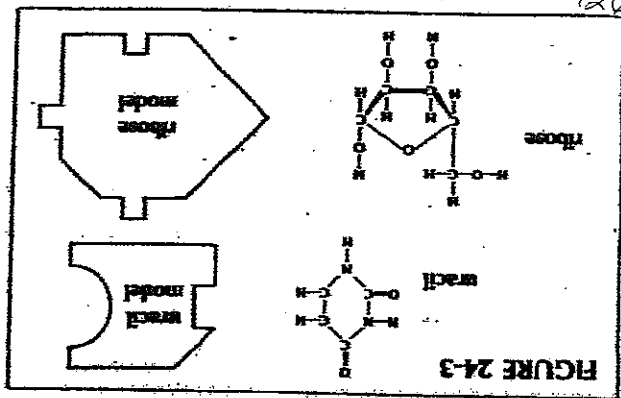
19. To which base in DNA do the following RNA bases pair?

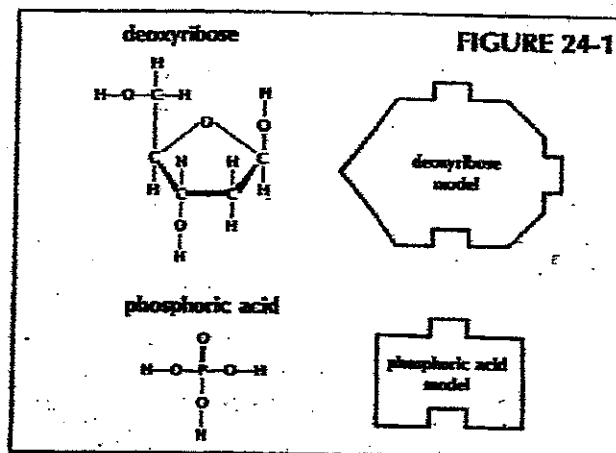
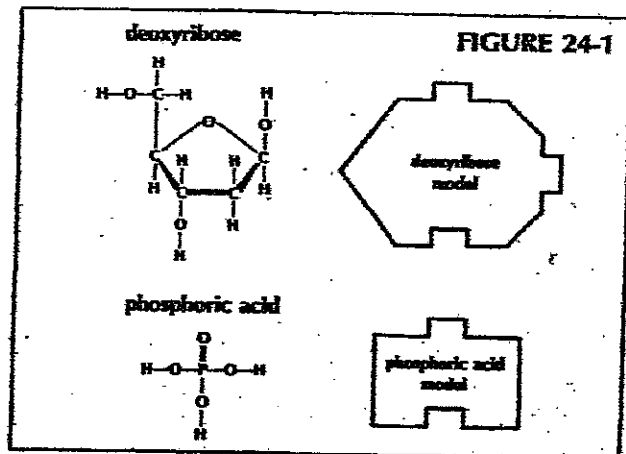
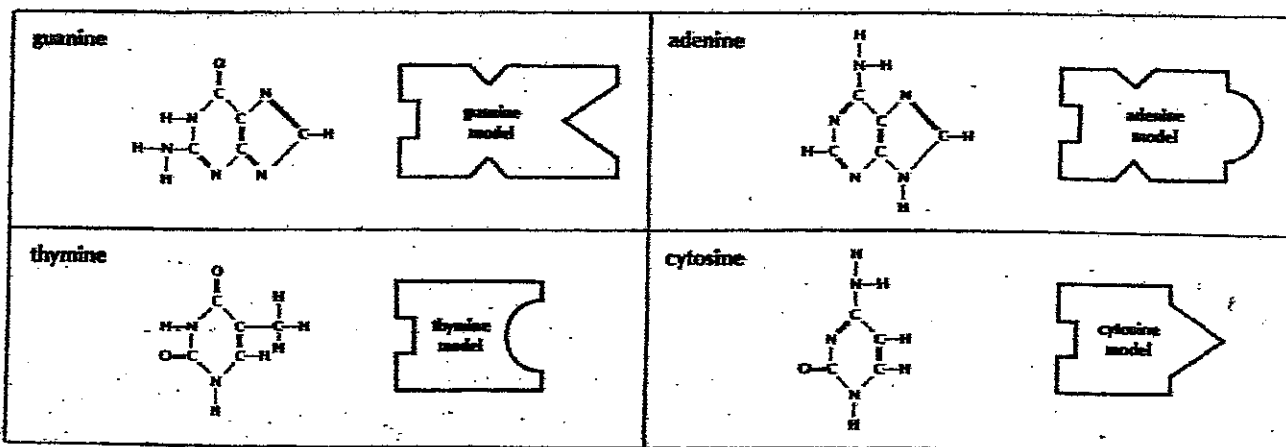
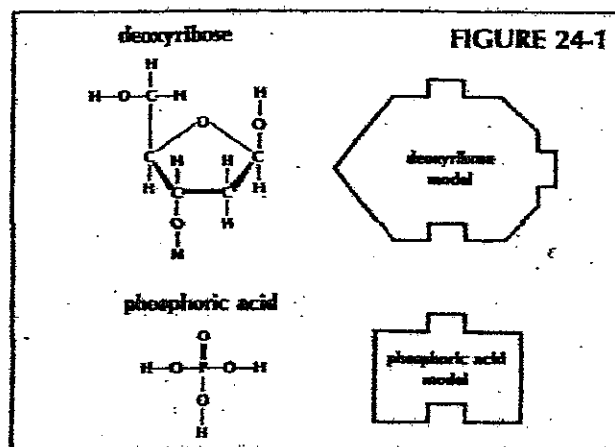
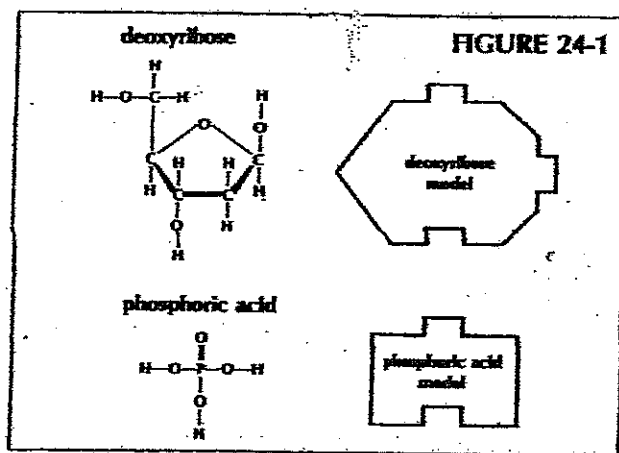
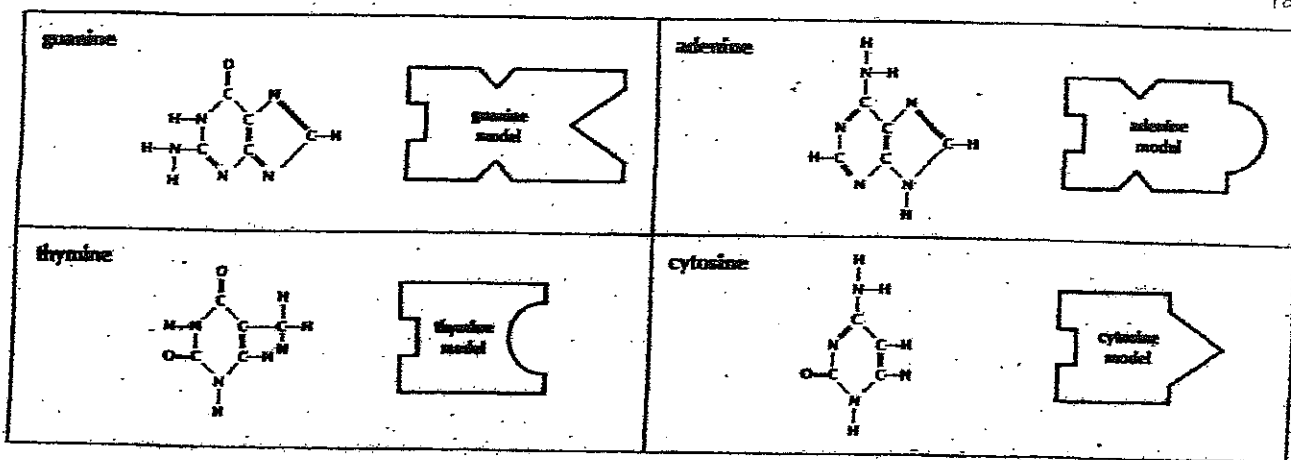
(a) guanine _____

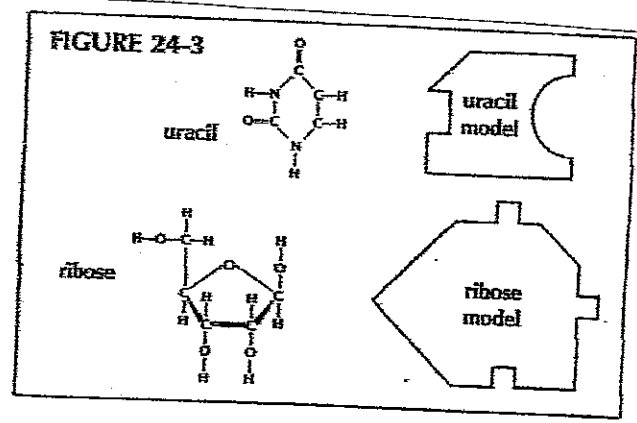
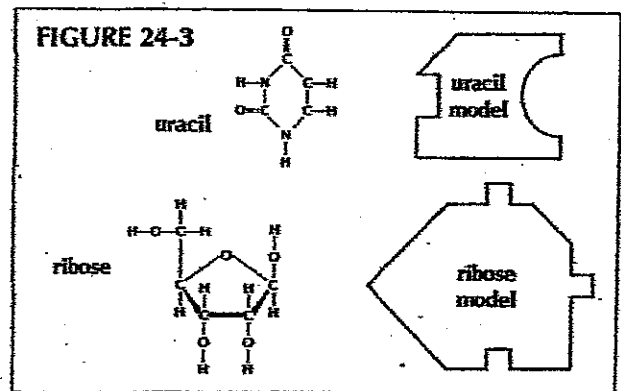
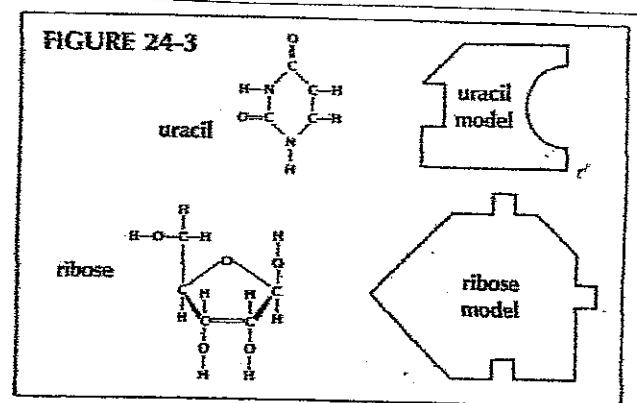
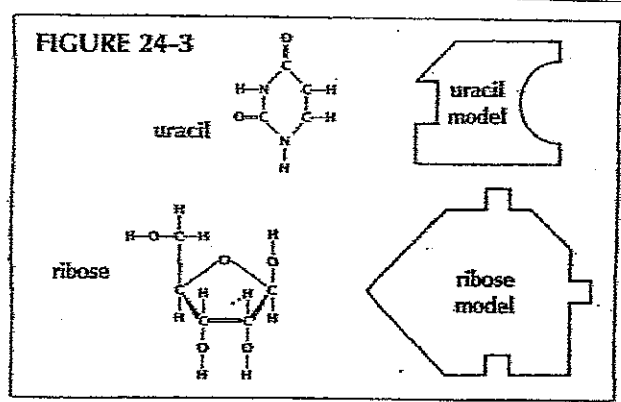
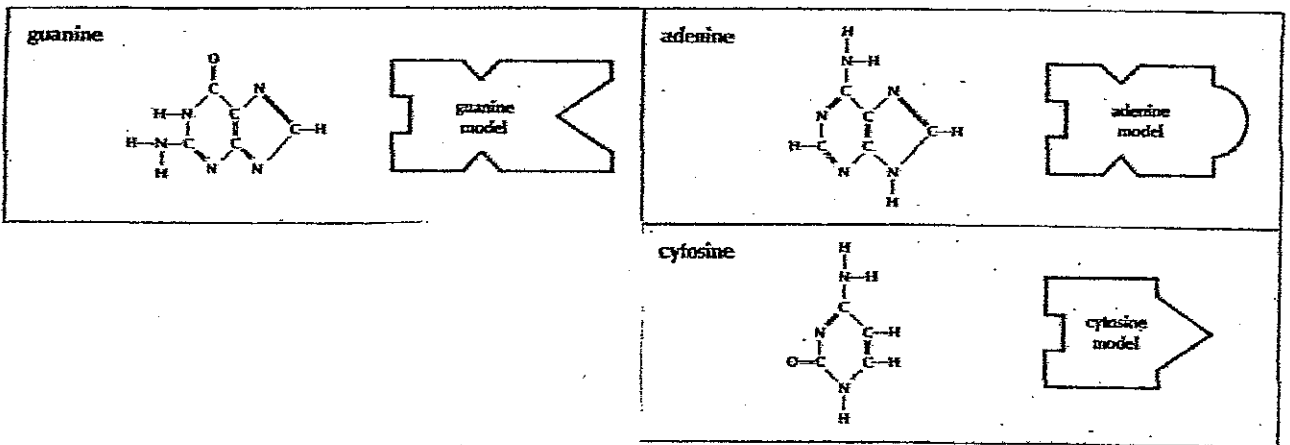
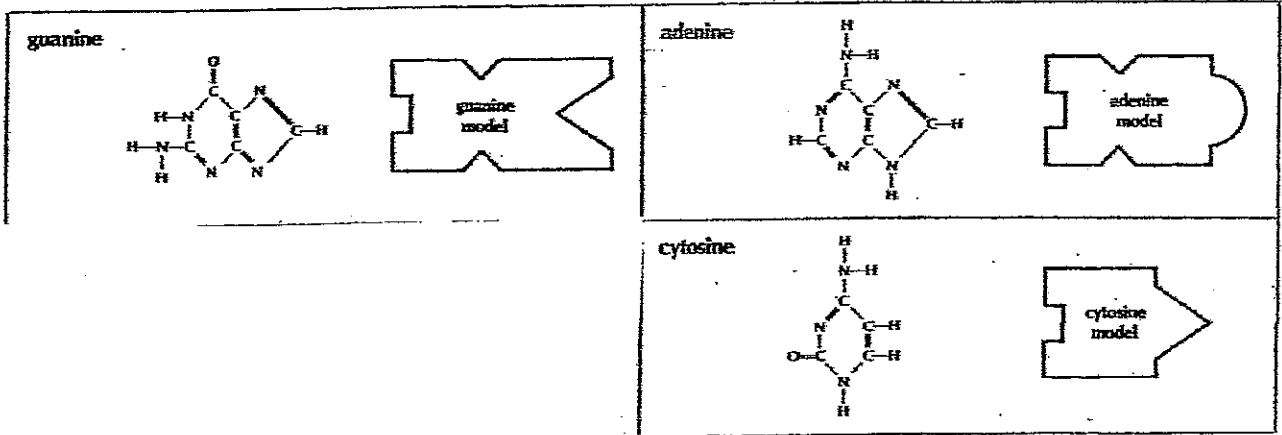
(b) adenine _____

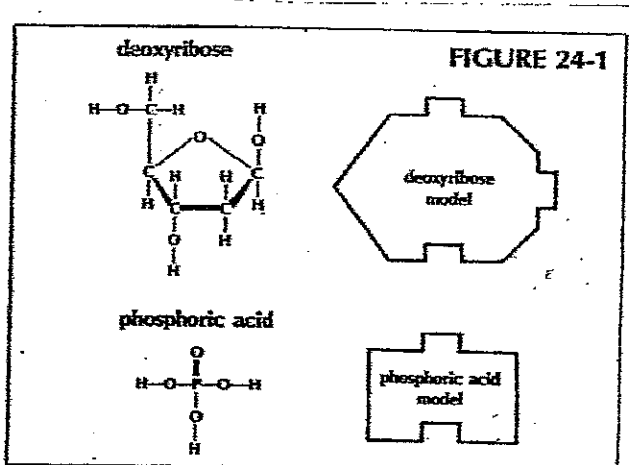
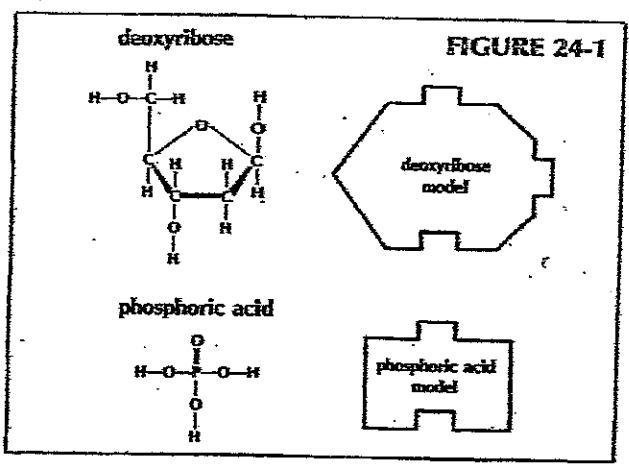
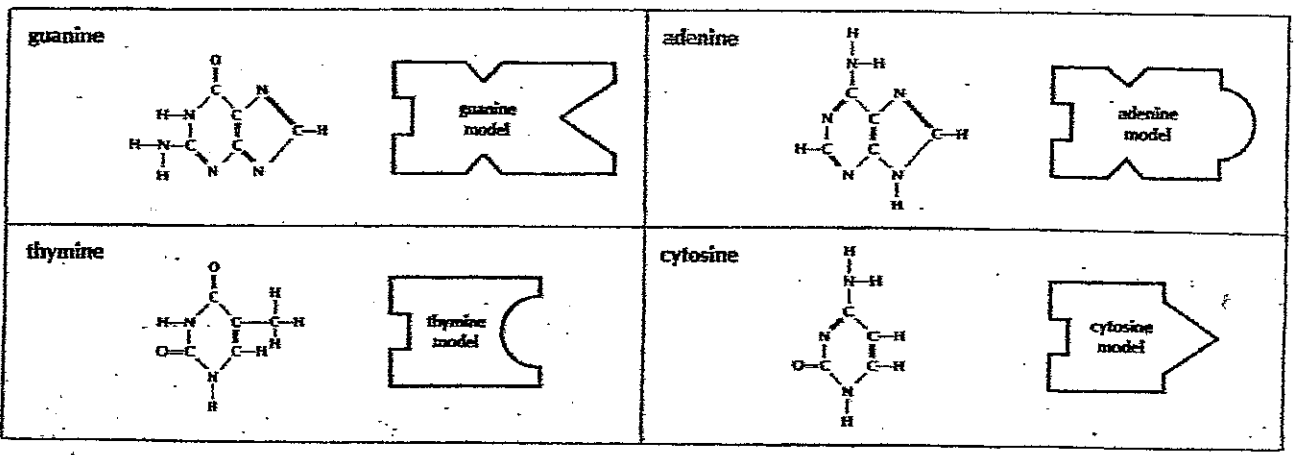
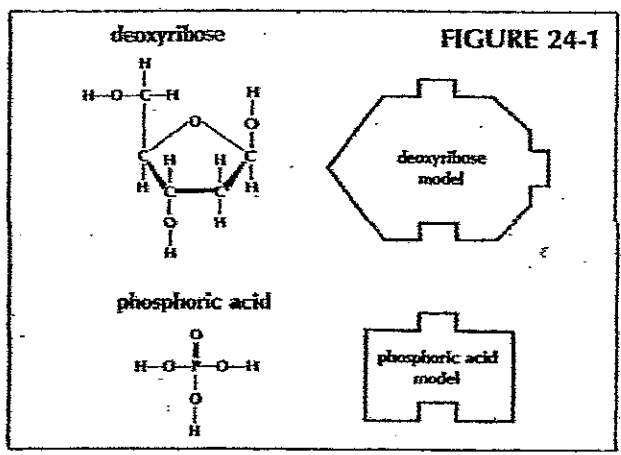
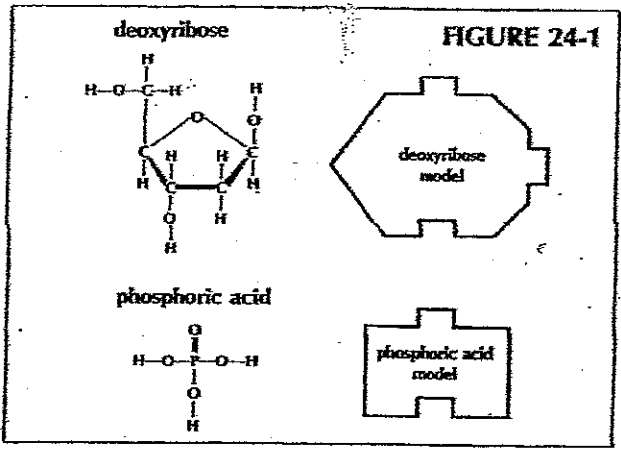
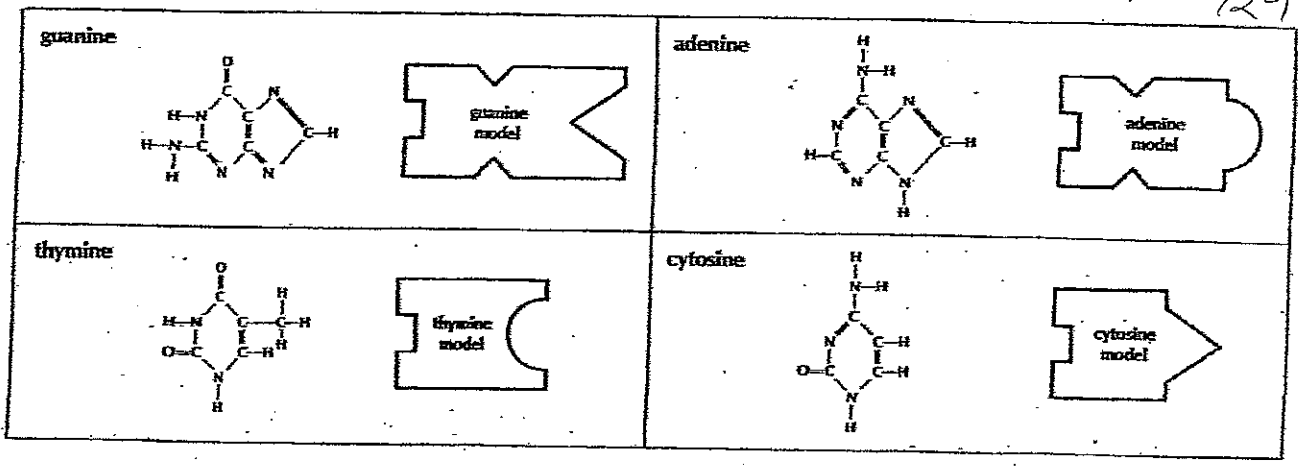
(c) cytosine _____

(d) uracil _____









Name _____

Date _____

Discovering DNA Structure

DNA contains the information for carrying out the activities of the cell. It was necessary to discover the structure of DNA before scientists could begin to understand the mechanisms of DNA Replication and the code for cell regulation. Today you will do a paper lab to help you understand the structure of DNA and show how the genetic information is carried.

- ⇒ Each member of your group has several pieces of molecule for building a **NUCLEOTIDE**. DNA is a nucleic acid that is composed of repeating units of nucleotides.

What are the **THREE** common parts of a nucleotide?

What is the **ONLY** part of a nucleotide that differs among the four **DIFFERENT** nucleotides in your group?

List the four different kinds of nitrogen bases.

Color the components of your nucleotide according to the following key:

Adenine = Yellow

Deoxyribose Sugar = Green

Phosphate = Red

Thymine = Orange

Cytosine = Purple

Guanine = Blue

- ⇒ Carefully cut out the templates for each of the DNA structures.
- ⇒ Match the shapes on the pieces and glue them together to form **ONE** nucleotide.
- ⇒ Within your group, manipulate the nucleotide pieces until you find the best fit. Join the nucleotide molecules together like a puzzle. Use tape or glue to connect and reinforce the molecules. You now have a molecule of DNA.

In the space provided, explain where the nucleotide molecules connect to each other.

⇒ Now, connect your groups DNA molecule with the other groups in the class to make one large DNA molecule.

What is the pairing arrangement of nitrogen bases?

_____ pairs with _____ and _____ pairs with _____

Are there always going to be an equal number of adenine and thymine nucleotides in a molecule? Why or why not?

Are there always going to be an equal number of guanine and cytosine molecules in a molecule of DNA? Why or why not?

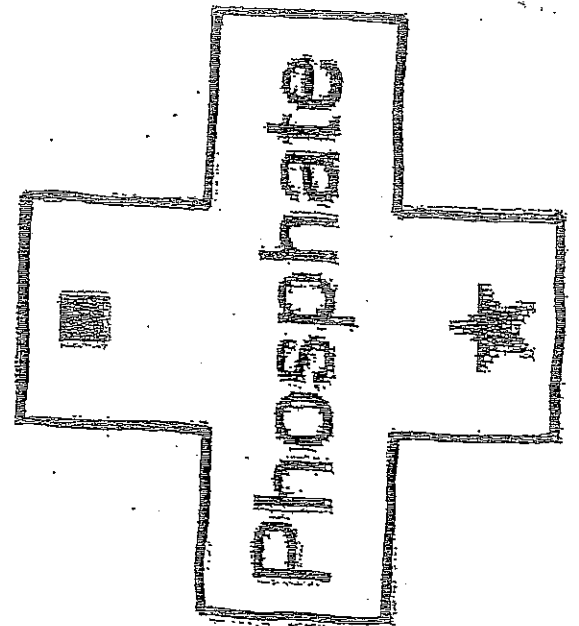
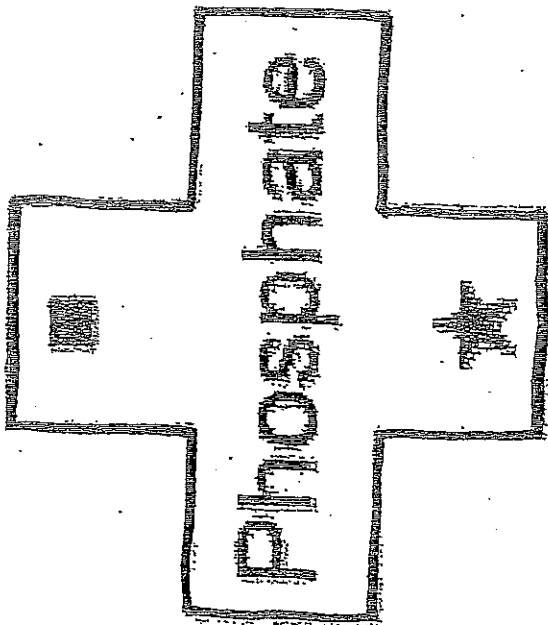
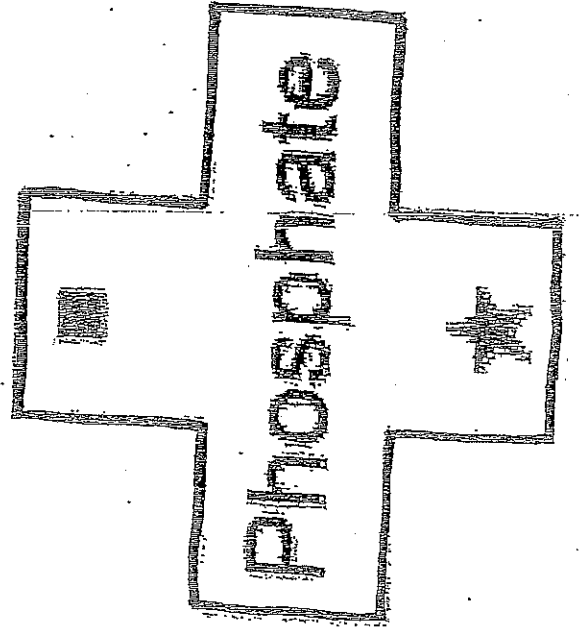
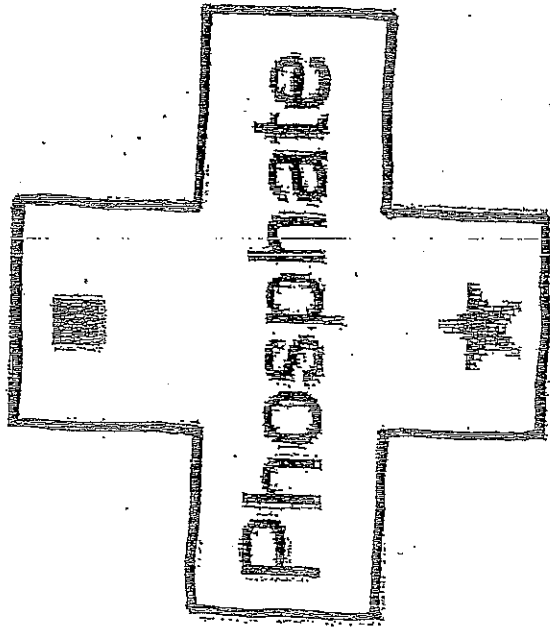
Scientists abbreviate the nitrogen bases by using the first letter of each base. So,

A always binds to _____

G always binds to _____

The shape of the DNA molecule is a double helix or twisted ladder. Describe how the DNA molecule is shaped like a ladder. Indicate how the components of the nucleotides build a ladder.

In the space provided below, use the letters to show the sequence of the bases in the DNA molecule that your group constructed. Begin at the top left side of your molecule.



Deoxyribose
sugar



Deoxyribose
sugar

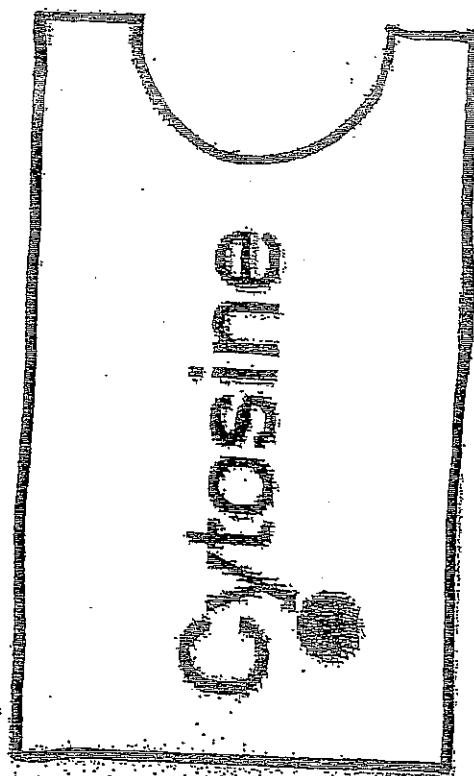
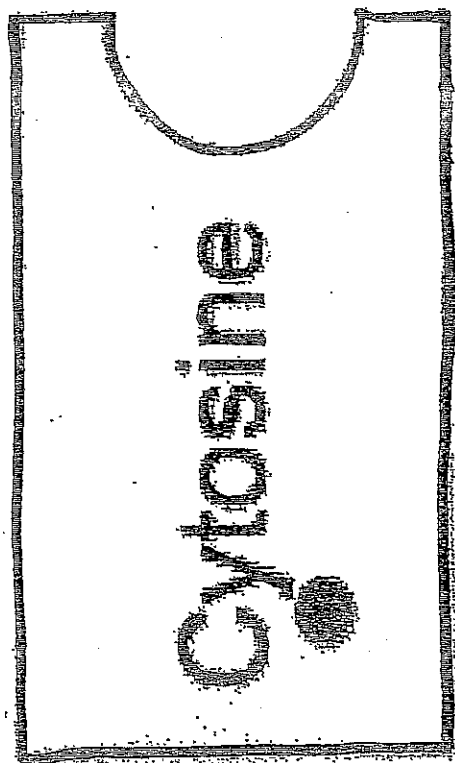
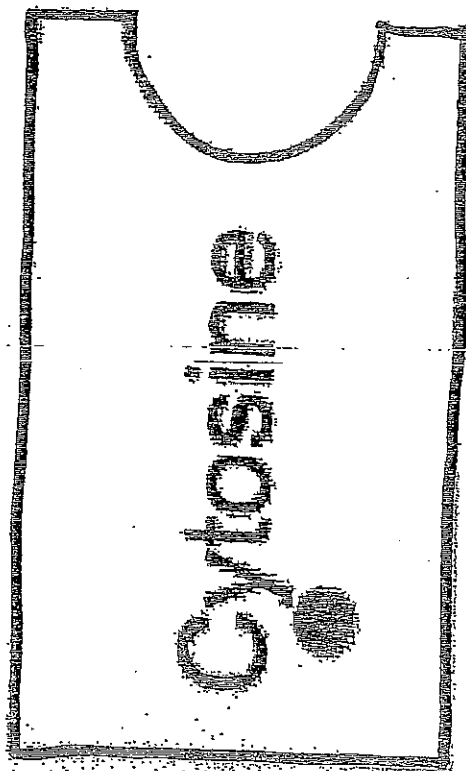
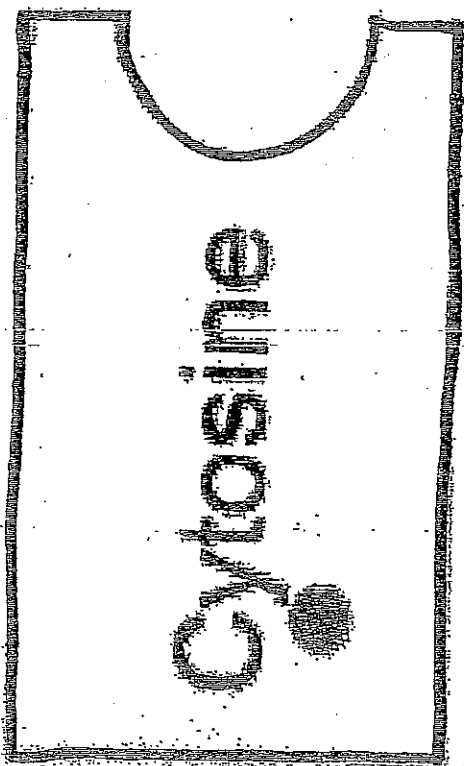


Deoxyribose
sugar



Deoxyribose
sugar



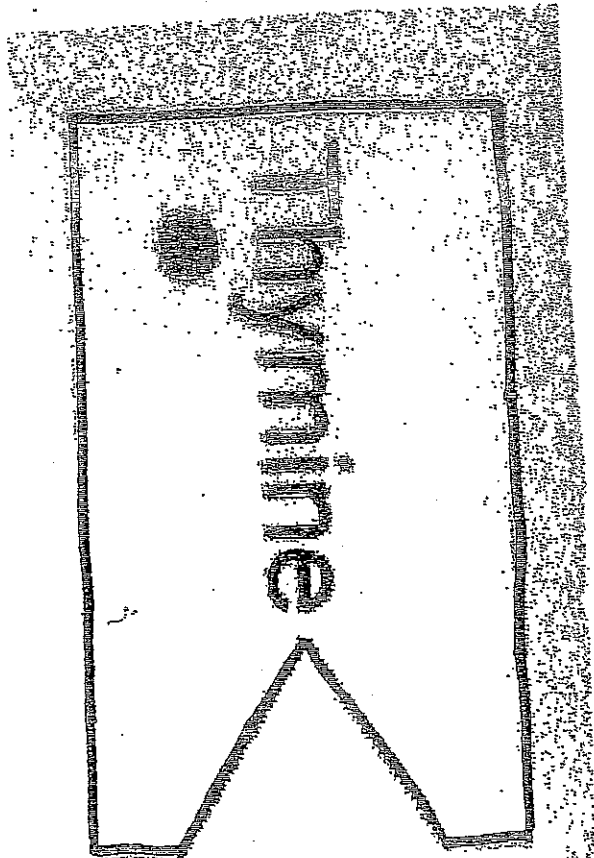
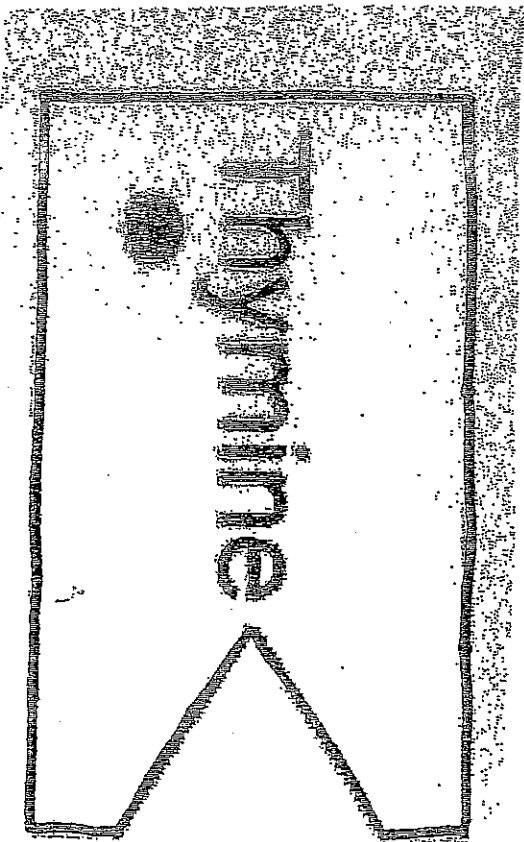
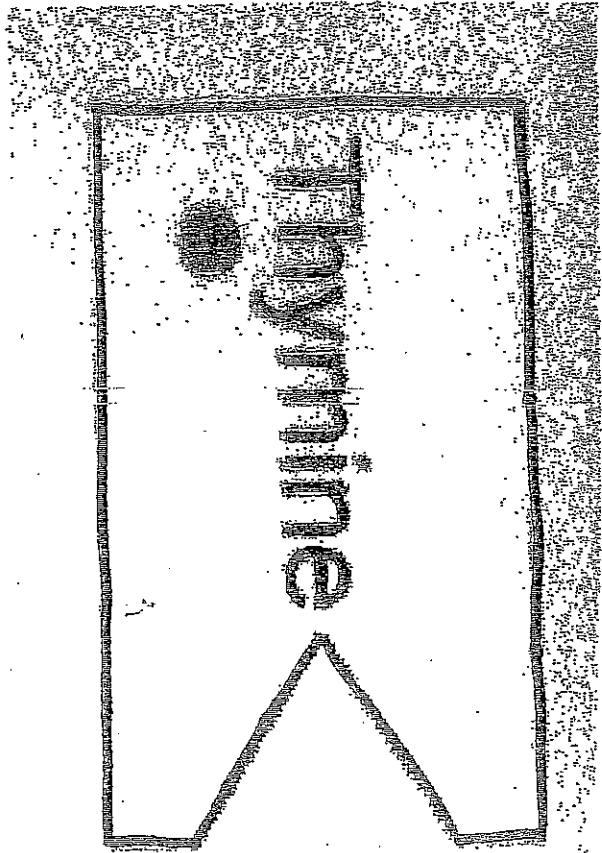
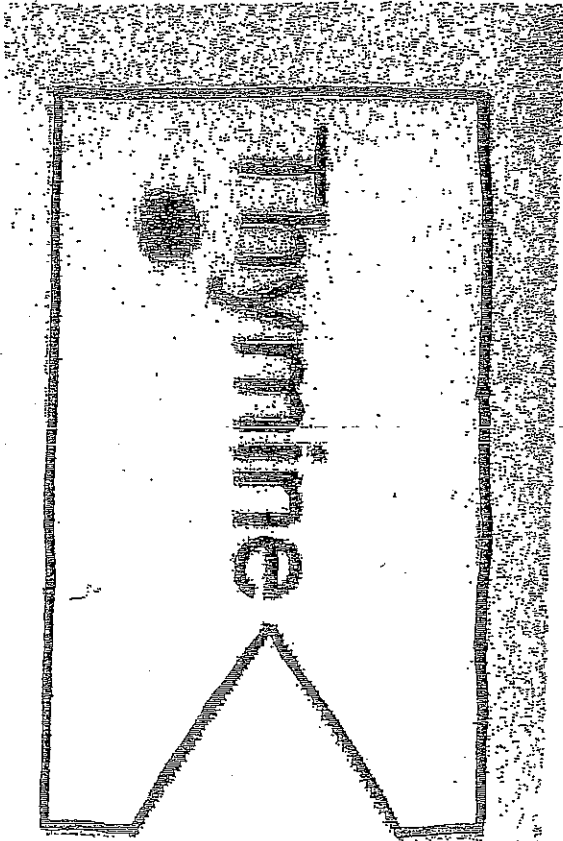


Guanine

Guanine

Guanine

Guanine



37-
Adenine

Adenine

Adenine

Adenine

Name _____

Period _____ Date _____

Protein Synthesis Simulation Lab

Part 1: Introduction

DNA is a very long, thin molecule located in the nucleus. The DNA in one chromosome has 10s of millions of base pairs and hundreds or thousands of genes. Yet an individual cell will only use a small portion of those genes in its lifetime. Imagine a mechanic who spends a lifetime fixing nothing but cars, but he or she is required nonetheless to carry around an entire library of repair manuals for everything from kitchen sinks to washing machines to light fixtures to computers and so on – all information the mechanic will never be able to use because s/he's busy fixing cars.

Another peculiar thing about DNA is that it is located inside the nucleus, and pretty much stays inside the nucleus, yet the proteins that DNA helps to make are produced OUTSIDE of the nucleus. So how does the cell solve this problem? It sends a "messenger" from the nucleus to the ribosomes in the cytoplasm.

In a process called transcription, the DNA code is transcribed (copied) into mRNA, following rules similar to DNA replication we saw earlier (see below). mRNA moves out of the nucleus into the cytoplasm where it links up with ribosomes and begins churning out proteins.

Recall that DNA consists of a sugar-phosphate backbone with a nitrogenous base. There are 4 different bases in DNA abbreviated with the letters A, T, C, & G. The code contained in DNA derives from these 4 bases. We can think of them as letters in an alphabet that will spell different words. In a real language, words can be anywhere from 1 letter long (a, I) to an upper limit of 10-15 letters for functional, non-compound words.

In DNA code, a "word" is always 3 letters long and is called a "codon." Consider the following DNA segment:

A	T	C	G	T	C	C	A	A	A
T	A	G	C	A	G	G	T	T	T

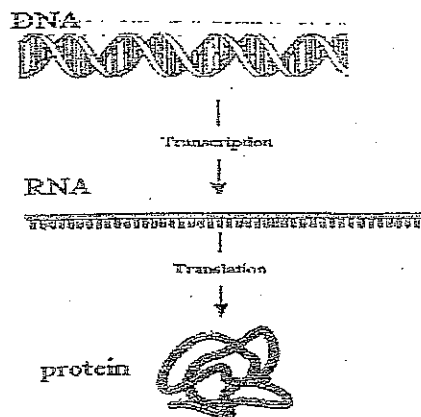
"ATC" is a codon. "GTC" is a codon. "CAA" is a codon. Etc.

In transcription, the DNA code is transcribed (copied) into RNA code, following rules similar to DNA replication we saw earlier EXCEPT that:

DNA	RNA
<i>Matches with</i>	
A.....	U
T.....	A
C.....	G
G.....	C

1. Transcribe the following DNA sequence into mRNA. Draw a line separating each codon:

A T C G T C C A A A



9.

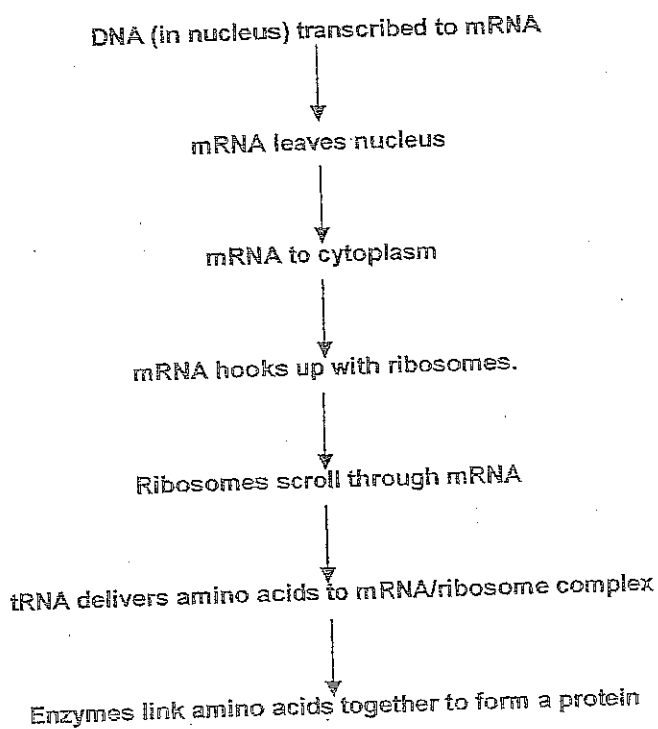
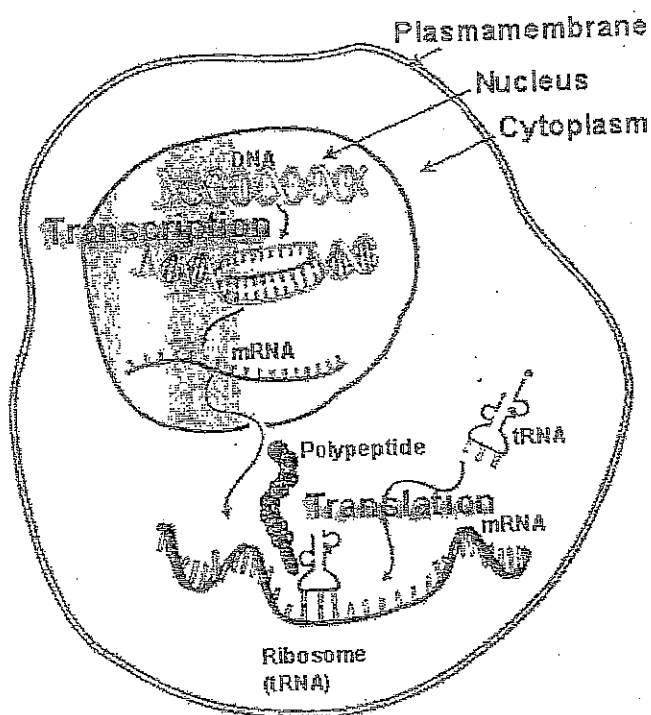
Name _____

Period _____ Date _____

2. Transcribe the following DNA sequence into mRNA. Draw a line separating each codon::

T A G C A G G T T T

Each mRNA codon corresponds to an amino acid that is transported to the RNA/ribosome complex by another special nucleic acid called tRNA. "T" stands for transfer. The ribosome essentially "reads" the RNA code and facilitates the linking of appropriate amino acids to make proteins. Summary diagram:



Activity: There are 4 letters of the mRNA code: U-A-C-G. How many possible combinations are there? In other words, how many "words" can you make with those 4 letters if any combination of letters is possible but all "words" are only 3 letters long? Hint -- start with a single letter, how many codons can be produced that start with, for example, the letter "A?" You can infer the rest. I'll get you started...

AAA
AAC
AAU
AAG

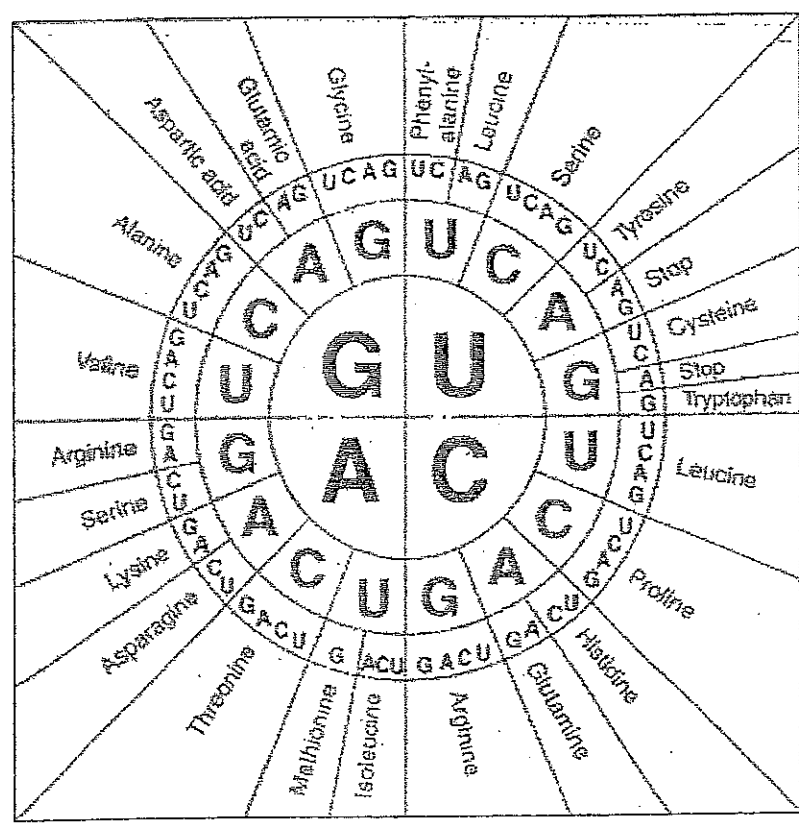
Name _____

Period _____ Date _____

Part 2: Questions

1. At this point, you should have figured out that there are _____ possible codons using 4 letters with 3 letters per codon in any order. However, there are only 20 amino acids, and each codon "codes" for one amino acid – so what does this mean?

The table below shows which amino acid corresponds with which codons.



2. What does UAC code for?

3. CAG? _____
4. AGG? _____
5. GAU? _____
6. UUU? _____
7. List the codons for Valine:

8. Stop? _____
9. Methionine is a "Start" signal. What is its codon?

Each amino acid is matched with one or more 3-letter "words." The words are analogous to an amino acid. When the words are put together they make a sentence. The sentence is analogous to a protein. So, let's break the following code.

10. Given the following DNA code, how would this segment be transcribed into mRNA?

T A C C C G A T A C T C C C T T C A A T T

11. Give the 3-letter abbreviation (see p. 4) for the amino acids coded for in that sequence:

12. What is the silly little sentence that this codes for (see p. 4)?

Name _____

Period _____ Date _____

Amino Acid -- English word Table

MET START	GLY THE	ALA SAD	VAL RAT	ILE MET
PHE RAN	HIS OLD	TRP FOE	PRO SLY	SER CAT
THR WHO	GLU SAW	CYS MAD	ARG ATE	TYR DOG
ASN AND	GLN HIS	ASP FOR	LEU DAY	LYS BIG
		STOP		

Abbreviation Table

NAME	CODE
Alanine	ALA
Cysteine	CYS
Aspartic Acid	ASP
Glutamic Acid	GLU
Phenylalanine	PHE
Glycine	GLY
Histidine	HIS
Isoleucine	ILE
Lysine	LYS
Leucine	LEU
Methionine	MET
Asparagine	ASN
Proline	PRO
Glutamine	GLN
Arginine	ARG
Serine	SER
Threonine	THR
Valine	VAL
Tryptophan	TRP
Tyrosine	TYR

In the remaining space, create your own messages and, working backwards, determine what the DNA sequence would be:

Your message: _____

Amino acid (3 letter): _____

mRNA sequence: _____

DNA Sequence: _____

Your message: _____

Amino acid (3 letter): _____

mRNA sequence: _____

DNA Sequence: _____

Determining the Traits of a "Mystery Organism" Through Protein Synthesis

Introduction:

Genes determine what characteristics an organism will have. Genes are segments of DNA molecules that determine what proteins the cells will make. The sequence of nucleotides in DNA determines the sequence of amino acids in the proteins. In a process called transcription, which takes place in the nucleus of the cell, messenger RNA (mRNA) is made from DNA and carries the instructions for how to make certain proteins. These instructions must be taken to the ribosomes where proteins are made. mRNA carries the instructions from the nucleus to the ribosomes. Once at the ribosome, transfer RNA (tRNA) reads the message, gathers the necessary amino acids, and brings them to the ribosome. The amino acids are lined up, and connected together by peptide bonds to form a protein. This process is known as translation.

In this lab, you will be creating a "mystery organism". You must determine which proteins must be made to produce your mystery organism. You will be simulating the process of protein synthesis to determine the traits this organism will inherit. Your mystery organism belongs to the Animal Kingdom. It is made up of 6 different genes (A, B, C, D, E, and F). Each of these genes is responsible for a certain trait.

Purpose:

1. To determine the traits on a particular chromosome.
2. To see how the traits on a chromosome determine the characteristics of an organism.
3. To observe transcription and translation from a DNA template.

Materials: Colored Pencils Paper

Safety Precautions: None

Procedure:

1. Look at the boxes in the data table. You have been given the DNA sequence of 6 different genes that compose a mystery organism. From the DNA sequence given, determine the mRNA codons, the tRNA anticodons, the amino acid sequence, and the trait (protein) made by linking those amino acids.
2. To determine what traits your mystery animal has, fill in the boxes in the data table.
3. To determine the amino acid sequence, refer to the list below. This list contains all codons and their amino acid sequence.

There are 20 different amino acids. A combination of many different amino acids composes different types of proteins. One amino acid is called for by one codon. A codon is a sequence of three nitrogen bases. There are 64 possible combinations of bases (codons), but only 20 amino acids. Several codons may be used to call for the same amino acid.

Amino Acid	Codons for this Amino Acids
------------	-----------------------------

Alanine	GCA, GCC, GCG, GCU
Arginine	AGA, AGG, CGA, CGC, CGG, CGU
Asparagine	AAC, AAU
Aspartic Acid	GAC, GAU
Cysteine	UGC, UGU
Glutamic Acid	GAA, GAG
Glutamine	CAA, CAG
Glycine	GGA, GGC, GGG, GGU
Histidine	CAC, CAU
Isoleucine	AUA, AUC, AUU
Leucine	UUA, UUG, CUA, CUC, CUG, CUU
Lysine	AAA, AAG
Initiator - Methionine	AUG
Phenylalanine	UUC, UUU
Proline	CCA, CCC, CCG, CCU
Serine	AGC, AGU, UCA, UCC, UCG, UCU
Threonine	ACA, ACC, ACG, ACU
Tryptophan	UGG
Tyrosine	UAC, UAU
Valine	GUA, GUC, GUG, GUU
Terminator	UAA, UAG, UGA

4. To determine what traits are present in your mystery organism, refer to the table below. Use the amino acid sequences from your data table to determine what characteristic is being called for.

AMINO ACID SEQUENCE	TRAIT
Alanine – Histidine – Lysine	Walks on four legs
Proline – Serine – Phenylalanine – Glycine	Freckles
Tryptophan – Proline – Isoleucine	Walks upright on two legs
Serine – Tryptophan – Lysine	Small purple ears
Cysteine – Alanine	Blue hair, very hairy
Arginine – Histidine – Threonine	Yellow eyes
Histidine – Valine	Very little red hair
Alanine – Glycine – Proline – Serine	No Freckles
Serine – Lysine	Short orange nose
Lysine – Leucine	Long red nose
Tyrosine – Isoleucine – Aspartic Acid	Blue eyes
Proline – Alanine – Alanine	Green elephant ears

Data Table:

GENE A	GENE B	GENE C
DNA: ACC GGT TAT	DNA: ACG CGA	DNA: TTT AAC
mRNA:	mRNA:	mRNA:
tRNA:	tRNA:	tRNA:
Amino Acid Sequence:	Amino Acid Sequence:	Amino Acid Sequence:
Trait:		

GENE D	GENE E	GENE F
DNA: GGA CGC CGA	DNA: GGG AGG AAA CCC	DNA: GCT GTG TGC
mRNA:	mRNA:	mRNA:
tRNA:	tRNA:	tRNA:
Amino Acid Sequence:	Amino Acid Sequence:	Amino Acid Sequence:
Trait:		

OBSERVATION QUESTIONS:

1. Distinguish between transcription and translation?
2. Where does transcription take place? Where does translation take place?
3. How does the ribosome know which proteins to make and how to make them?
4. List the steps in protein synthesis.
5. List 10 different kinds of proteins that might be made by the ribosomes?
6. Distinguish between a codon and an anticodon.
7. Random mutations may occur that cause a change in the order of nitrogen bases in a codon. One mutation involves the substitution of one of the nitrogen bases in a codon. Explain the effect of a substitution of one of the bases in a codon.
8. What would be the effect of an addition or a deletion of one of the bases in a codon?
9. Using colored pencils, draw your mystery organism.

Name _____

Date _____

Mitosis

15

A single fertilized human egg cell will divide to form two cells. These two cells will each divide into two cells. In time, millions of cells are produced. The division of nuclear material in which each new nucleus obtains the same number of chromosomes and the same nuclear code as the original nucleus is called mitosis. Mitosis occurs in four phases. There is an interphase between each mitosis.

In this investigation, you will

- locate cells in prepared onion root slides that are in the process of dividing by mitosis.
- identify cells in interphase and in each of the four stages of mitosis in the onion root tips by comparing them with diagrams.
- study the changes which occur in a cell as it undergoes mitosis.

Materials



microscope
prepared slides of onion root tip (*Allium*), longitudinal section

Procedure

- Locate with a microscope the region of rapidly dividing cells on the prepared slide of onion root tip as shown in Figure 15-1. After locating the cells under low power, switch to high power.
- Locate cells that appear to be in the various stages of mitosis. Use Figure 15-2 as a guide.
- Identify and label the following stages by using the brief description provided. Write the correct stage name on the lines provided in Figure 15-2.
 - Interphase*—cell contains easily seen nucleus and nucleolus—chromosomes appear as fine dots within nucleus
 - Prophase*—cell nucleus enlarged—nucleolus no longer visible—chromosomes appear as short strands within nucleus
 - Metaphase*—chromosomes long and thin strands—chromosomes lined up along cell center and look like "spider on a mirror"
 - Anaphase*—two sets of separate chromosomes can be seen—look as if they are being pulled apart from one another
 - Telophase*—chromosomes appear at opposite ends of cell—middle of cell has line across center that divides it almost into two new cells
 - Daughter cells*—appear as cells in interphase but smaller and side by side—actually start of new interphase

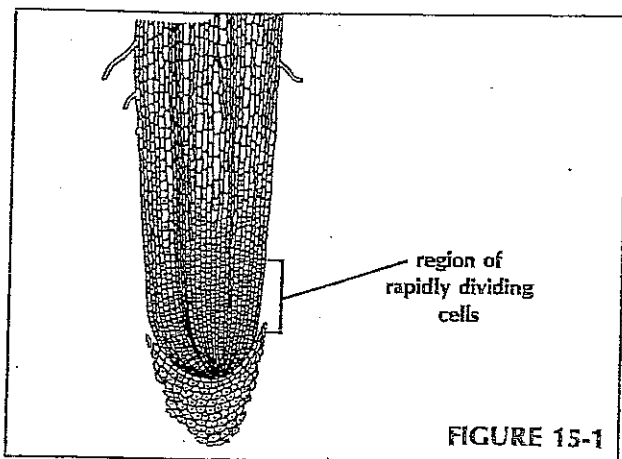


FIGURE 15-1

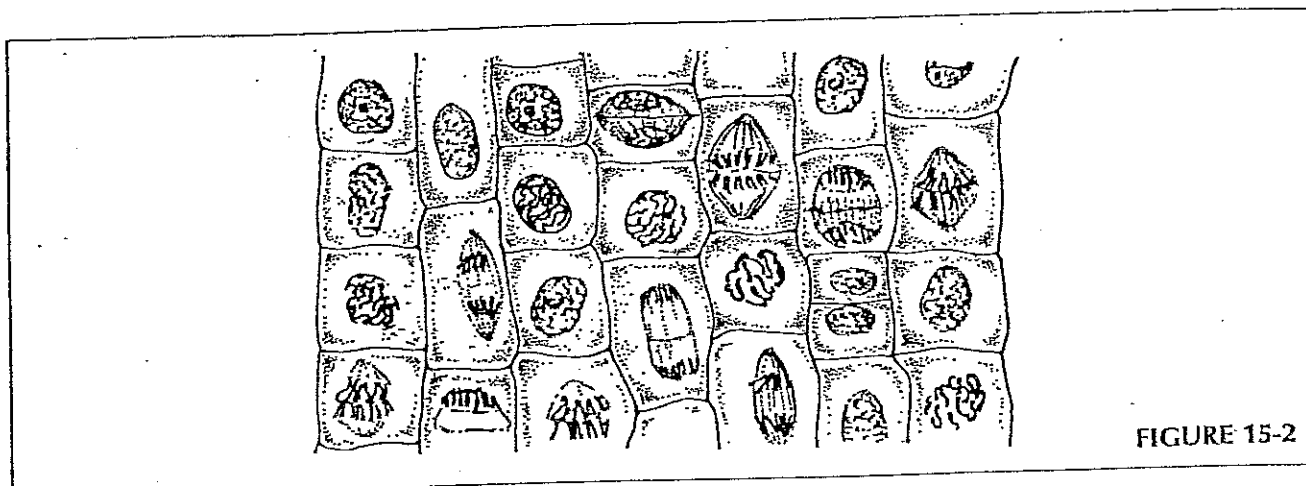
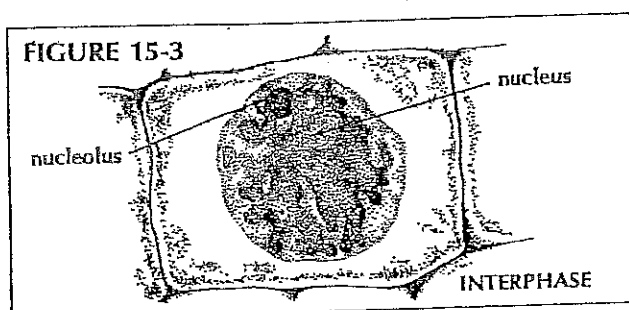


FIGURE 15-2

• Answer the following questions about each of the phases of mitosis.



Interphase

• Locate cells resembling Figure 15-3. Answer questions 1-3 while observing these cells.

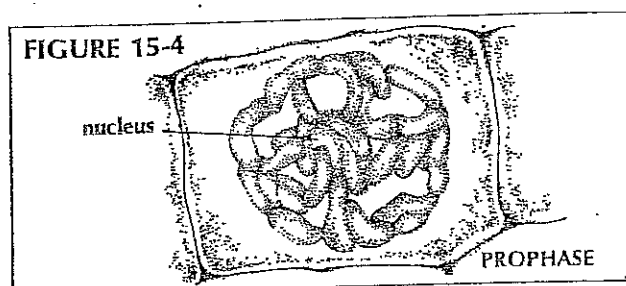
1. Describe the contents of a nucleus during interphase. _____
2. Are a nucleolus and nuclear membrane present in the cell? _____
3. Are distinct rod-shaped structures called chromosomes easily observed in the nucleus at this time? _____

• Use your text for reference while answering questions 4-6.

4. Are chromosomes present in cells during interphase? _____
5. What term is used to describe nuclear contents during interphase? _____

somes during interphase? _____

- (b) What other important events occur during interphase? _____



Prophase

• Locate cells resembling Figure 15-4. Answer questions 7 and 8 while observing these cells.

7. Are chromosomes now visible during prophase? _____
8. Describe the changes that have occurred to the nucleolus and nuclear membrane from interphase to prophase. _____

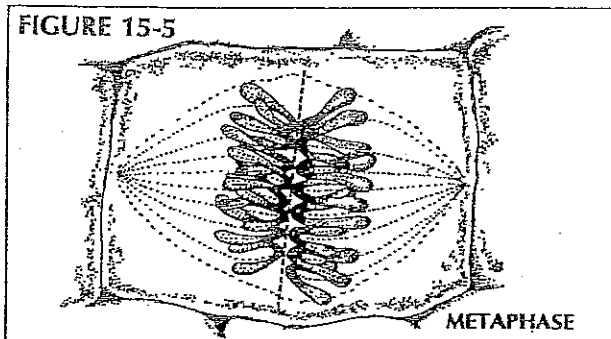
• Use your text for reference while answering question 9.

9. Explain why chromosomes can now be observed but were not observable during interphase. _____

Name _____

Date _____

FIGURE 15-5



METAPHASE

Metaphase

• Locate cells resembling Figure 15-5. Answer questions 10 and 11 while observing these cells.

10. Describe where the chromosomes are now located in relation to the cell. _____

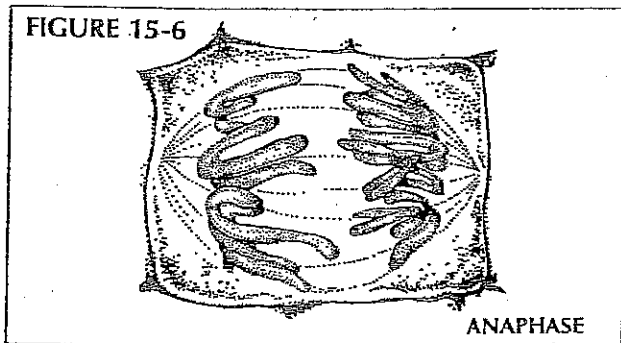
11. Can evidence of chromosome duplication (replication) now be observed? _____

• Use your text for reference while answering questions 12 and 13.

12. What are the fibers called that become visible during this phase? _____

13. What term is used to describe the structure at which each fiber attaches to a chromosome? _____

FIGURE 15-6



ANAPHASE

Anaphase

• Locate cells resembling Figure 15-6. Answer questions 14 and 15 while observing these cells.

14. In metaphase, chromosome pairs were lined up along the cell's center. Describe what is occurring to each chromosome pair during anaphase. _____

15. Toward what area of the cell are the chromosomes being directed? _____

• Use your text for reference while answering question 16.

16. What structure is responsible for the movement of chromosomes during this phase? _____

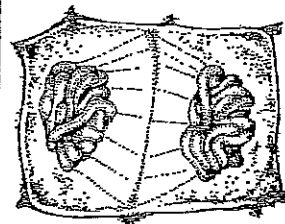
Telophase

• Locate cells resembling Figure 15-7. Answer question 17 while observing these cells.

17. What cell parts begin to reappear during this phase? (See question 8.) _____

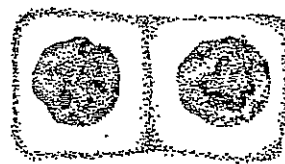
18. Describe the location of the chromosomes now compared to where they were during metaphase. _____

FIGURE 15-7



TELOPHASE

FIGURE 15-8



DAUGHTER CELLS

Daughter Cells

• Locate cells resembling Figure 15-8. Answer questions 19 and 20 while observing these cells.

19. How many cells have now formed from an original cell? _____

20. Explain how the number of chromosomes found in each daughter cell compares to the number found in the original cell before mitosis. (HINT: Read introduction.) _____

Analysis

1. The term "mitosis" comes from the Greek word meaning "thread." Explain why this word may be helpful in describing this process of nuclear division. _____

2. Explain how the process of mitosis helps an organism to grow in size. _____

3. Complete Figure 15-9 to show the structures visible during each stage of mitosis. Draw in and/or label the structures listed below on the appropriate diagram. Be sure to label each animal cell with the correct mitosis stage name.

(a) *Interphase*: draw and label *nuclear membrane*, *nucleolus*, *chromatin*, *centriole*.

(b) *Prophase*: label *disappearing nuclear membrane*, *disappearing nucleolus*, *original chromosomes* (shaded), *chromosome copies* (unshaded).

(c) *Metaphase*: draw in the two chromosome pairs as they would appear during metaphase. Label *chromosomes*, *spindle fibers*.

(d) *Anaphase*: draw in the two chromosome pairs as they separate in anaphase. Label *centromeres*.

(e) *Telophase*: label *reforming nuclear membrane*, *reforming nucleolus*, *pinching in of cell membrane*.

(f) *Interphase*: draw in and label *nucleus*, *nucleolus*, *nuclear membrane*, and *chromatin* in each cell.

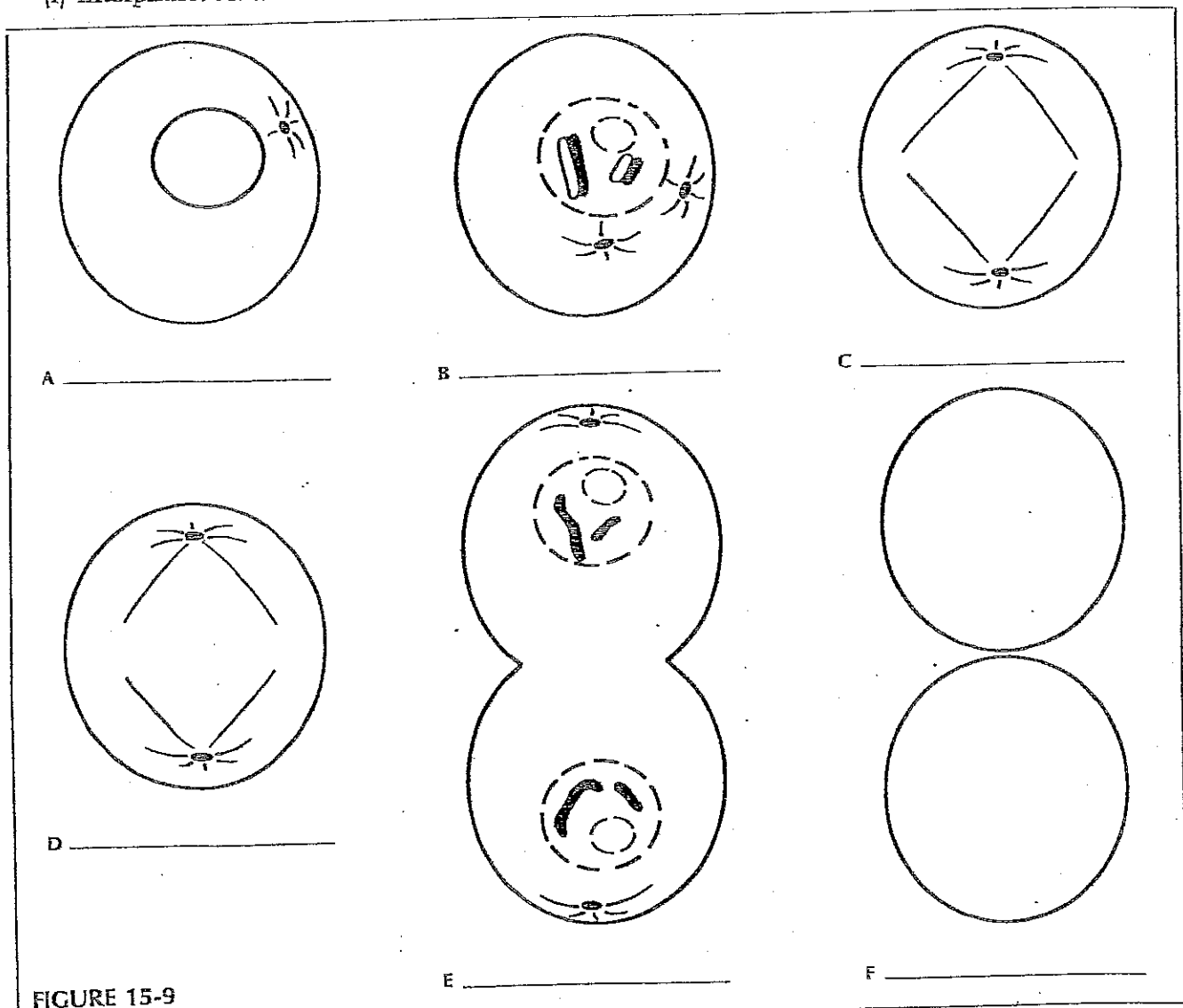


FIGURE 15-9

Name _____

Date _____

Time For Mitosis

16

Do all phases of mitosis require the same amount of time for completion? This question can be answered by counting the number of onion root tip cells in the four phases of mitosis and in interphase. Many cells in one specific phase indicate that a long period of time is required for completion of that phase. Few cells in a specific phase indicate a short period of time is required for completion of that phase.

In this investigation, you will

- use prepared slides of onion root tip cells to locate cells in mitosis and interphase.
- count the number of cells in each of the phases of mitosis and in interphase.
- compute the length of time in minutes needed to complete each phase.
- compare data of the time needed for normal cells to complete each phase with that of abnormal cancer cells.

Materials



microscope
prepared slides of onion root tip (*Allium*), longitudinal section

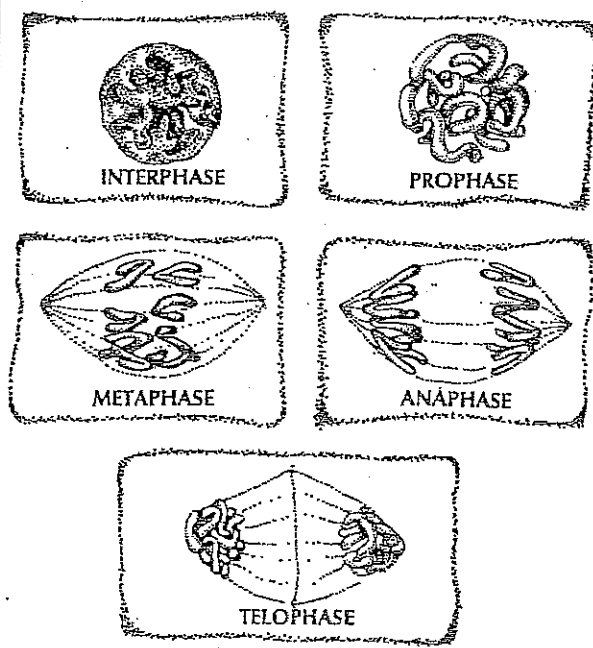
Procedure

Part A. Locating and Counting Cells in Mitosis

- Locate under the microscope on an onion root tip slide an area with cells in the process of mitosis. After locating the cells under low power, switch to high power.
- Count and record in Table 16-1 the number of cells in each mitotic phase and in interphase. Count all cells in the field of view. Use Figure 16-1 as a guide to the phases of mitosis.
- Move the slide so you are looking at a new area of cells.
- Count and record the number of cells in each mitotic phase and in interphase for this area.
- Repeat for a third new area.
- Total the number of cells counted in each phase and interphase for the three areas. Record this figure in the column marked "Total Number of Cells in Each Phase" of Table 16-1.

- Add the total number of cells viewed in each phase and interphase together to get the total of all cells counted. Record this number in Table 16-1.

FIGURE 16-1



Part B. Determining the Time Required for Each Phase

Assume that the number of cells in a phase is an indication of the time spent in that phase during mitosis. Time spent in a mitotic phase and in interphase can be calculated if the total time for mitosis is known. Onion cells require 12 hours (720 minutes) to complete mitosis (from interphase to interphase). The amount of time needed for a phase can be calculated using the formula:

$$\text{time for a phase} = \frac{\text{number of cells in a phase}}{\text{total number of cells counted}} \times 720 \text{ minutes}$$

For example: If 109 cells were counted in metaphase and 980 total cells were counted, then

$$\frac{109}{980} \times 720 \text{ minutes} = 80 \text{ minutes}$$

• Calculate the time required for each phase of mitosis using your data. Use the total of the three areas counted. Assume that the total time for mitosis is 720 minutes.

• Record the times in Table 16-1.

TABLE 16-1. RESULTS OF COUNTING CELLS IN EACH PHASE OF MITOSIS AND INTERPHASE					
PHASE	FIRST AREA	SECOND AREA	THIRD AREA	TOTAL NUMBER OF CELLS IN EACH PHASE	TIME IN MINUTES
Interphase					
Prophase					
Metaphase					
Anaphase					
Telophase					
			Total number		

Analysis

- Which phase requires the longest time for completion? _____
- Which phase requires the next longest time for completion? _____
- Which phase requires the shortest time for completion? _____
- The following table shows average times required for normal and diseased chicken stomach cells to complete mitosis.
 - In normal chicken cells, which phase requires the longest time for completion? _____
 - In normal chicken cells, which phase requires the next longest time for completion? _____
 - How do your answers to questions 4a and 4b compare with answers to questions 1 and 2? _____

Name _____

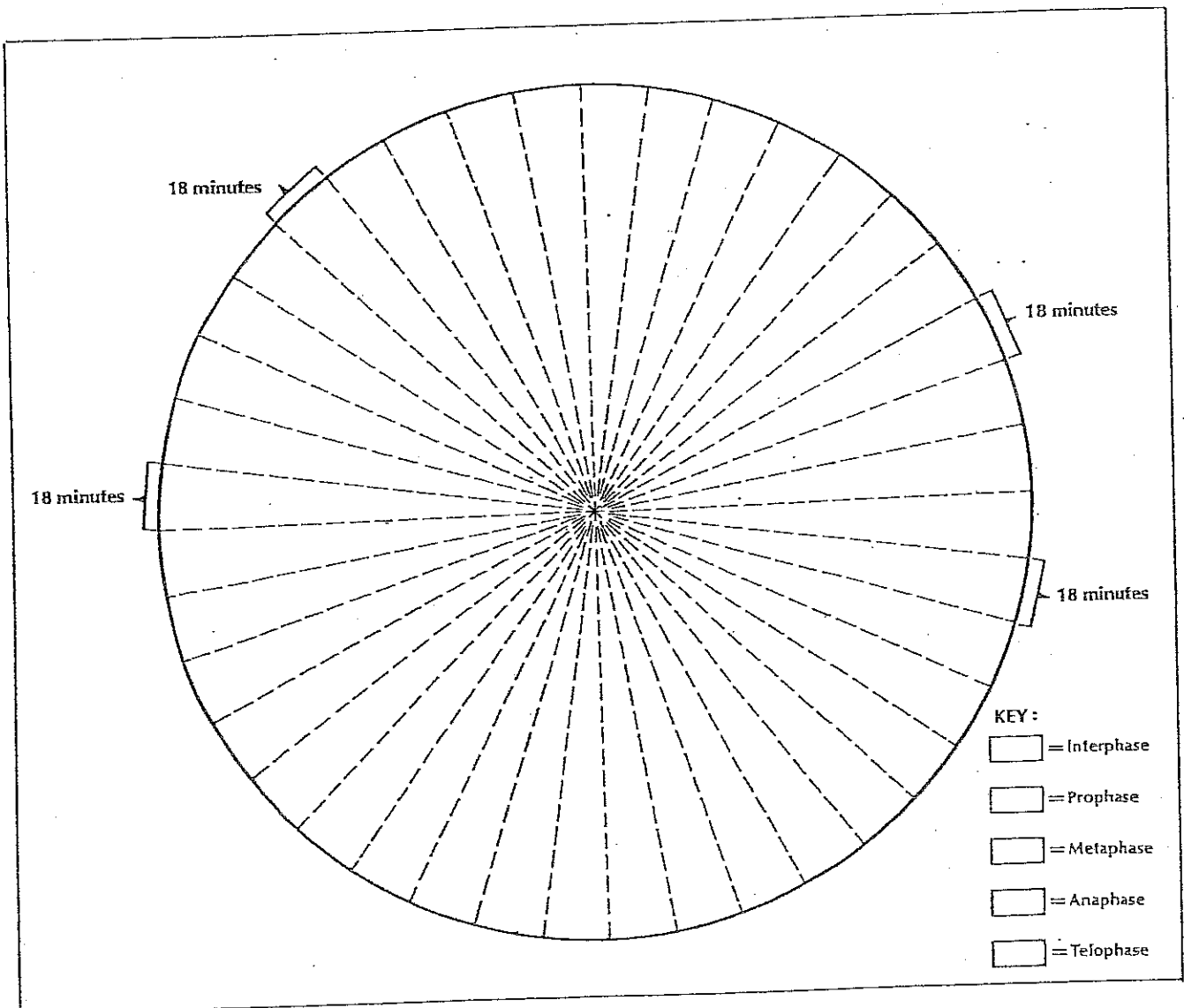
Date _____

TABLE 16-2. TIME FOR MITOSIS OF NORMAL AND CANCEROUS CHICKEN STOMACH CELLS (IN MINUTES)		
	NORMAL CHICKEN STOMACH CELLS IN MINUTES	CANCEROUS CHICKEN STOMACH CELLS IN MINUTES
Interphase	540	380
Prophase	60	45
Metaphase	10	10
Anaphase	3	3
Telophase	12	10

5. (a) What is the total time needed for a normal chicken stomach cell to complete mitosis? (Total up the time in minutes for each phase.) _____
- (b) What is the total time needed for a cancerous chicken stomach cell to complete mitosis? _____
6. How do cancer cells differ from normal cells in total time required for mitosis? _____
7. How do cancer cells differ from normal cells in time spent for each phase? _____
8. Table 16-3 shows the length of time (in minutes) needed for mitosis to occur in 2 different normal living organisms.
- (a) Which organism, salamander or pea, shows time needed to complete mitosis most like the data you recorded in Table 16-1? _____
- (b) Why might the time required for these two organisms to complete mitosis be similar? (HINT: Where did the cell material you used in Part A come from?) _____

TABLE 16-3. TIMES NEEDED FOR MITOSIS					
	PROPHASE	METAPHASE	ANAPHASE	TELOPHASE	TOTAL
Salamander kidney cells	60	50	6	70	186
Pea root cells	80	40	4	12	136

- 12.
9. Using your data from Table 16-1 and the outline below, prepare a circle graph which shows the number of minutes that onion cells spend in each phase of mitosis. The following suggestions may aid you in preparing your graph.
- Graph your data using the "Time in minutes" column from Table 16-1.
 - The circle is divided into 18 minute sections. Each section of the graph equals 18 minutes. If a phase is not exactly 18 minutes long (or some interval close to a multiple of 18 minutes), approximate the position of the line on the graph.
 - Shade each phase on your graph with colored pencils or various degrees of pencil shading.
 - Identify each phase by shading the key to correspond with the shading on your graph.



10. Refer to the outline graph above when answering the following questions.
- What important changes occur in the nucleus and cell during the longest phase of mitosis?

- Why do you think so much time is spent in this phase?

Before doing this lab, have students read sections 10:3–10:6 in the text.

10–1 How Do Digestive System Lengths Compare?

You know that the diet of different animals may vary. You can buy cat food, dog food, and bird food in most supermarkets.

The length of the digestive system may also vary. Animals that eat plants usually have longer digestive systems than animals that eat meat.*

*This is the key phrase to the activity.

GOALS

In this exercise, you will:

- measure the length of the digestive system in three animals.
- compare these lengths with the type of food eaten.

KEYWORDS Direct students to the text or the lab glossary for help. Define the following keywords:

caecum _____

carnivore _____

digestive system _____

herbivore _____

MATERIALS

string metric ruler scissors tape

A transparency of page 74 placed on an overhead and a demonstration with string may help get students started.

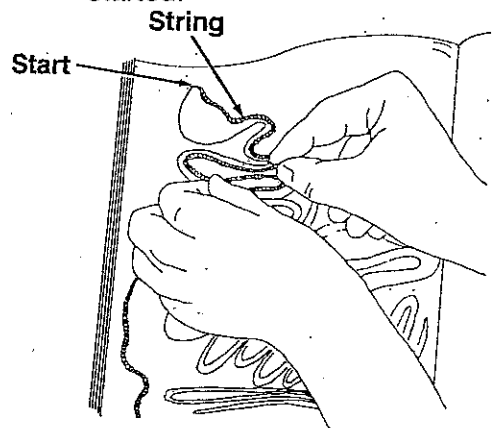
PROCEDURE

- Place a piece of string down on the outline drawing of the rabbit digestive system in Figure 2 on the next page. Figure 1 shows you how.
- Tape the end of the string in place at the label marked "start" on the stomach of the rabbit.
- Position the string only over the entire length of the *unshaded* organs. It must match, exactly, the many twists and turns of the stomach, the small intestine and the large intestine (the unshaded organs).
- When you reach the anus, cut the string, remove it from the drawing, and stretch it out its full length.

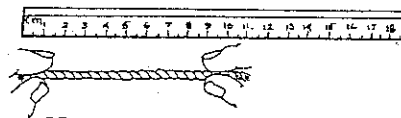
CAUTION: Use care with scissors.

- Measure the length of the string in centimeters and record this number in Table 1.

You may have students simply mark the end of the digestive system on the string. This will enable you to use the same piece of string for all 3 animals.



Measuring intestine with string



Measuring string with ruler

FIGURE 1. Measuring the digestive system

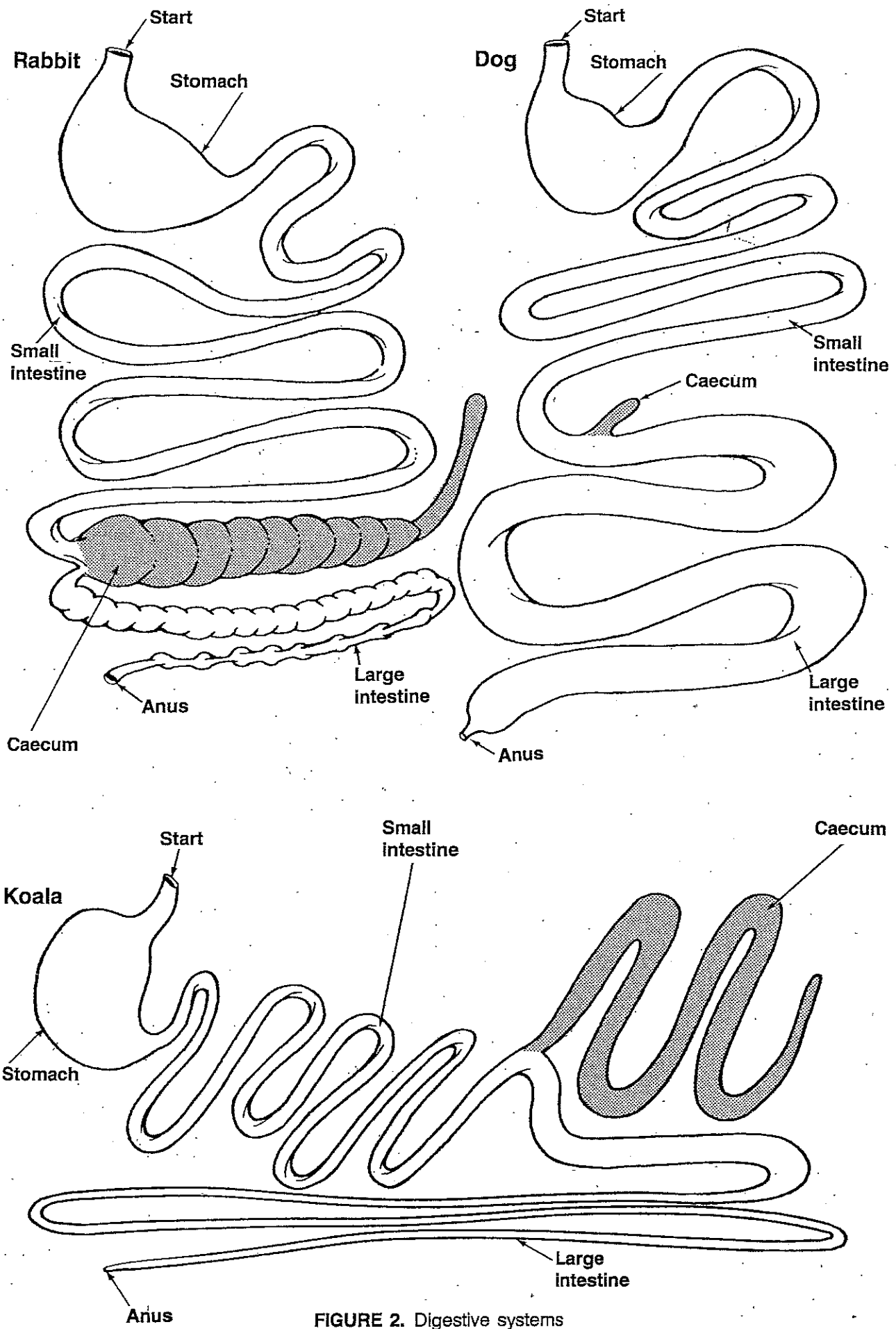


FIGURE 2. Digestive systems

Name _____ Class _____ Period _____

6. Position the string over the shaded portion of the rabbit digestive system and measure the length of the caecum. Record this measurement in centimeters in Table 1.
7. Add together the two numbers that you have now recorded in the table in order to get the total length of the digestive system. Record this number in Table 1.
8. The diagram of the rabbit digestive system is drawn $\frac{1}{3}$ smaller than actual size. Multiply the total digestive system length by 3*to complete the first row of Table 1. This number is the actual length of the rabbit digestive system.
9. Repeat steps 1 through 8 for the digestive system of the koala and the dog.

*Applicable only in this exercise.

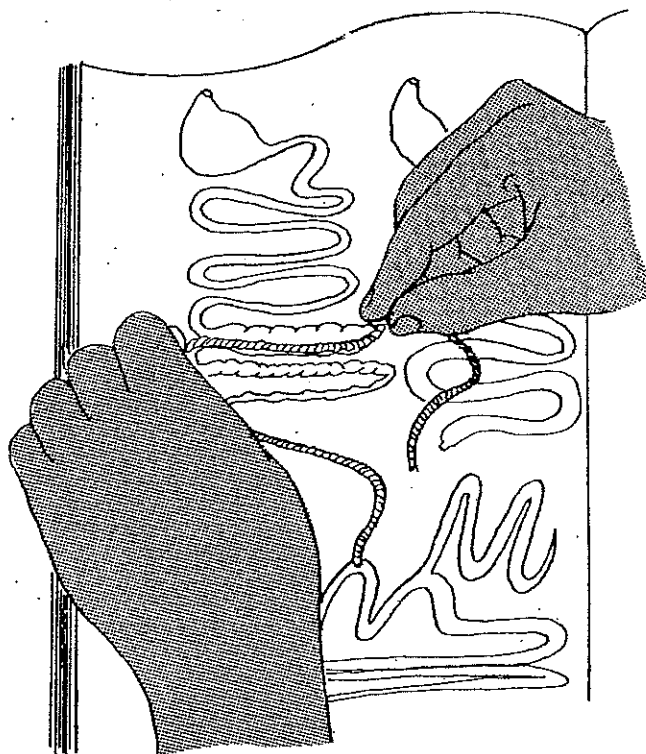


FIGURE 3. Measuring caeca of animals

Table 1. Digestive System Measurements

Animal	Length of stomach, small intestine, large intestine	Caecum length	Total digestive system length	Multiply by 3	Actual length of digestive system
Rabbit	+	=		x	=
Koala	+	=		x	=
Dog	+	=		x	=

QUESTIONS

1. Which animal has the longest actual digestive system? _____
2. Which animal has the shortest actual digestive system? _____
3. Based on what you already know, tell whether the animals used in this experiment are carnivores or herbivores. NOTE: The koala is an Australian animal that feeds only on the leaves and buds of the eucalyptus tree.

rabbit _____ koala _____ dog _____

4. Circle the correct answer to the following questions:

a. The animal that has the longest actual digestive system is a

(carnivore, herbivore).

b. The animal that has the shortest actual digestive system is a

(carnivore, herbivore).

c. The animal that has the longest caecum is a

(carnivore, herbivore).

d. The animal that has the shortest caecum is a

(carnivore, herbivore).

5. By using your answers to question 4, describe how the length of the digestive system in animals seems to be related to the type of food the animals eat.

6. Are plants or meat more difficult to digest? _____

Explain: _____

7. Use the word *long* or *short* to describe what you think the length of the digestive system might be in the

lion _____ cat _____ horse _____ deer _____

panther _____ donkey _____ cow _____ wolf _____

8. Two different animals of almost the same size have digestive systems that are of the following lengths:

Animal A—410 cm

Animal B—145 cm

a. Which one of these animals is most likely to be a carnivore? _____

b. Explain your answer. _____ Animal B is short

c. Which one of these animals is most likely to be a herbivore? _____

d. Explain your answer. _____ Animal A is long

Name _____

Date _____

Digestive System Of Frog And Human

62

No two animal types have exactly the same internal organs. However, animals in the same phylum should have organs that are somewhat similar. Frogs and humans are both chordates, and their internal organs, especially those of the digestive system, are similar. Thus, if you study the structures of the digestive system of a frog, it will help you better understand the structures of the human digestive system.

In this investigation, you will

- observe the digestive organs of a dissected frog.
- compare your observations of the frog's digestive system with diagrams of the human digestive system.
- determine similarities and differences in structures between the systems of these two animals.

Materials



frog, preserved
dissecting pan
scissors

pins
tweezers
hand lens

Procedure

Part A. Digestive System, External Parts

One can think of the digestive system as a long hollow tube extending through the body. This tube is open to the outside at both ends. One opening is called the mouth. The other opening in a frog is called the cloaca.

- Examine the mouth of your frog. The mouth can be opened more easily by cutting the edges of the jaw with scissors. **CAUTION:** Always be careful when using scissors. Use Figure 62-1 as a guide.

FIGURE 62-1

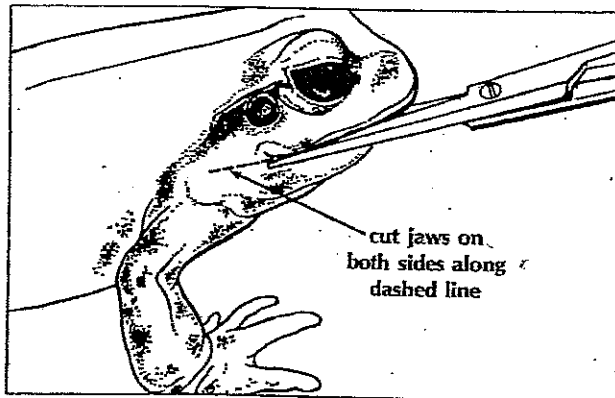


FIGURE 62-2

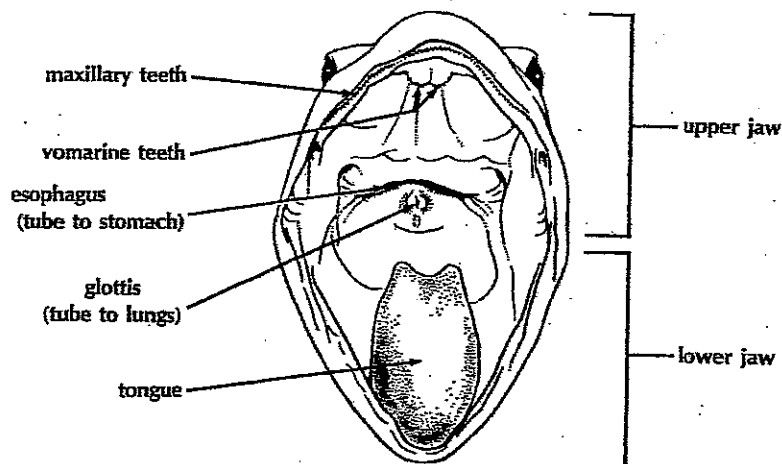
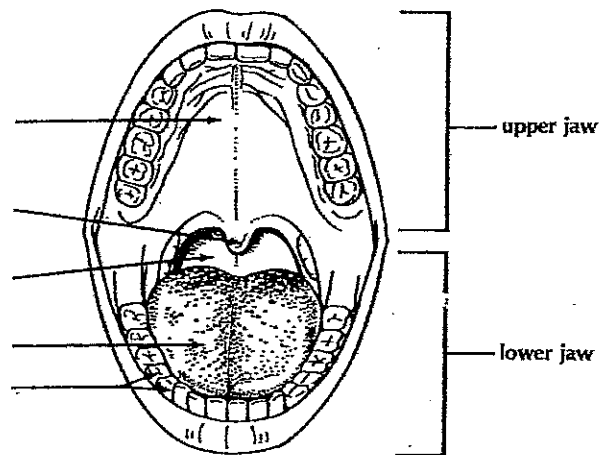


FIGURE 62-3



• Locate the five structures of a frog mouth using Figure 62-2 as a guide.

• Rub your finger along the inside edge of the frog's upper jaw. You should feel the maxillary teeth.

1. Are any maxillary teeth also felt along the lower jaw edge? _____

Use Figure 62-3 as a guide to the human mouth. Label the following parts: *teeth*, *pharynx* (space at back of mouth), *palate* (roof of mouth), *uvula* (small fleshy flap hanging from palate), *tongue*.

2. Compare the frog's tongue to the human's.

(a) How do the tip ends differ? _____

(b) How do the points of attachment to the lower jaw differ? _____

3. Compare the frog's teeth to the human's.

(a) How do the number of teeth differ? (Estimate the number of maxillary teeth in the frog.) _____

(b) How does their location differ? _____

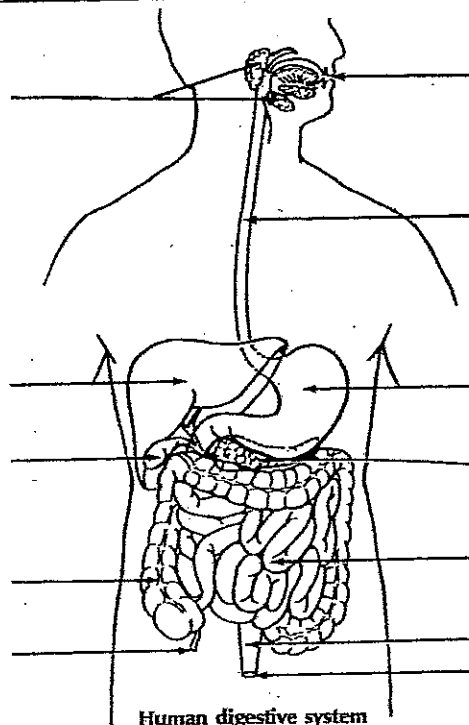
(c) How might their functions differ? (Frogs swallow their food whole.) _____

4. Can one easily see the esophagus and glottis in the human mouth? _____

Part B. Digestive System, Internal Parts

• Place your frog on its back in a dissecting pan.

FIGURE 62-6



• Examine Figure 62-6 showing a diagram of the human digestive system.

Before labeling its parts, note the following:

- (a) gall bladder and pancreas both connect by narrow tubes to the small intestine. Chemicals or enzymes formed or stored by these organs can empty into the small intestine.
- (b) large intestine consists of three main sections instead of just one in frogs.

• Label these parts: *liver, gall bladder, pancreas, stomach, small intestine, large intestine*. (Dashed lines indicate organs which lie below other organs.) Several parts not labeled or present on the frog diagram are shown in the human diagram. Label these five new parts:

- (a) *mouth*—opening to digestive system.
- (b) *esophagus*—tube leading from back of mouth to stomach.
- (c) *salivary glands*—small glands under tongue and in back of mouth connecting to mouth by way of narrow tubes.
- (d) *appendix*—fingerlike part where small and large intestines join.
- (e) *rectum*—connects large intestine to anus. (Replaces cloaca of frog.)
- (f) *anus*—opening to outside at end of rectum.

5. Compare the frog stomach to the human's.

(a) How do their shapes differ? _____

(b) How might their functions differ? _____

6. (a) Does the same part lead from mouth to stomach in both frog and human? _____

(b) Name this part. _____

7. Compare the frog large intestine to the human's.

(a) How do their shapes differ? _____

(b) Are both connected at one end to small intestine? _____

Part C. Parts of the Alimentary Canal

Certain digestive organs are like hollow tubes. Food is pushed through these hollow organs as digestion takes place. Other digestive organs are solid and food does not pass through them. Instead, these solid organs supply the hollow ones with enzymes or chemicals needed for digestion. The hollow organs through which food passes are said to be part of the body's alimentary canal. The first organ of the human or frog alimentary canal is the mouth.

• Determine which organs of the frog are or are not part of the alimentary canal. Use scissors (or single-edged razor blade) to remove a small section of liver, small intestine, stomach and large intestine.

Name _____

Date _____

• Examine each organ section with a hand lens and determine if it is hollow or solid. Record your results in Table 62-2.

• In the last column of Table 62-2, check those organs which are part of the alimentary canal. Note that certain organs have already been completed for you in the table. (Salivary glands are only present in the human.)

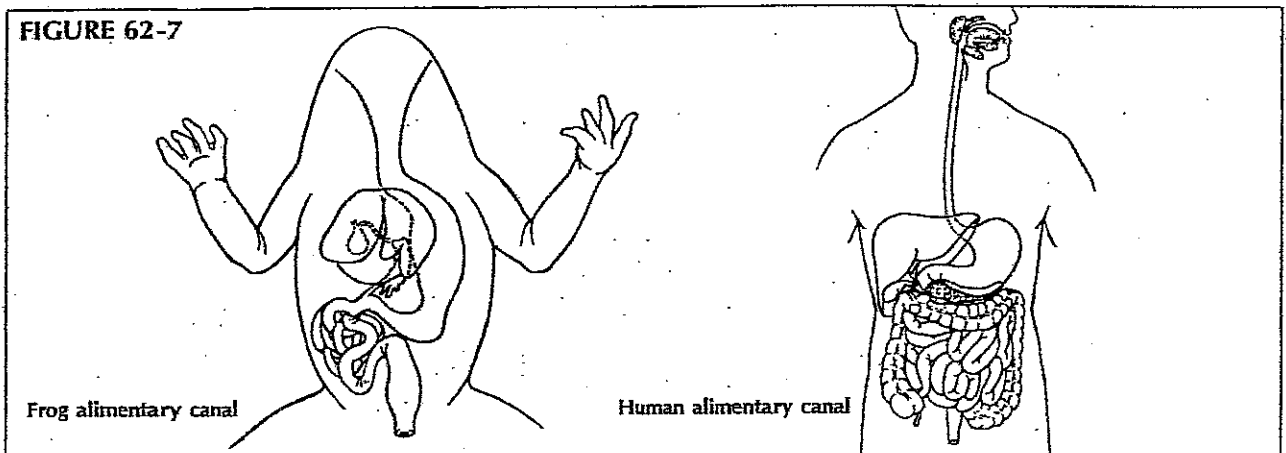
TABLE 62-2. ORGANS OF THE ALIMENTARY CANAL		
DIGESTIVE ORGAN	HOLLOW OR SOLID?	PART OF ALIMENTARY CANAL?
Salivary glands	Solid	
Mouth	Hollow	✓
Esophagus	Hollow	✓
Stomach		
Liver		
Pancreas	Solid	
Small intestine		
Large intestine		

Analysis

1. Digested food is absorbed into the bloodstream while it is in the small intestine. What structure seen in the frog small intestine helps absorb food at this point? _____

Explain your answer. _____

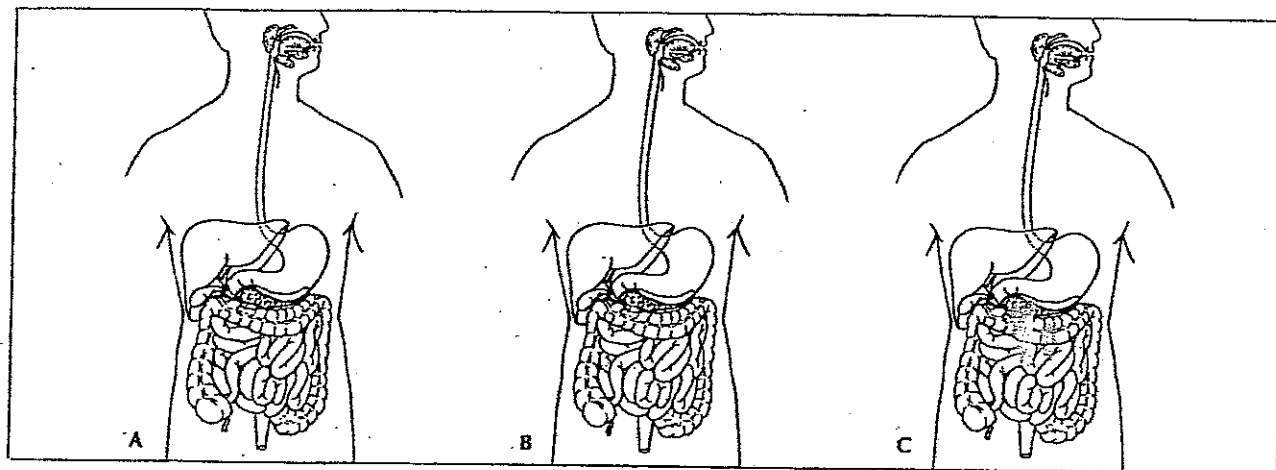
2. Shade in on the diagrams in Figure 62-7 only those organs which make up the alimentary canal of a frog and human.



3. (a) The liver makes a chemical called bile. Bile is stored in the gall bladder. How does bile reach the small intestine?
 (b) The pancreas makes several enzymes needed for digestion. How do these enzymes reach the small intestine?
4. Table 62-3 shows the various organs of the digestive system as well as the types of food acted upon by these organs.

TABLE 62-3. ORGANS OF THE DIGESTIVE SYSTEM	
ORGAN	FOOD TYPE ACTED UPON
mouth and salivary glands	carbohydrates
esophagus	none
stomach	protein
liver and gall bladder	fat
pancreas	fat, protein, carbohydrates
small intestine	fat, protein, carbohydrates
large intestine	none

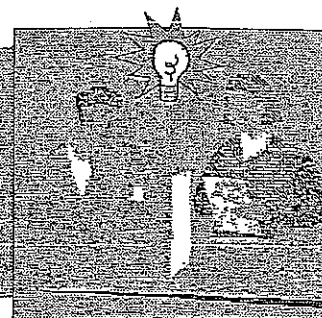
- (a) On diagram A below, shade in all organs which aid in carbohydrate digestion.
 (b) On diagram B below, shade in all organs which aid in fat digestion.
 (c) On diagram C below, shade in all organs which aid in protein digestion.



5. (a) On the basis of your shaded diagrams in both questions 2 and 4, which organ is probably the most important for digestion?
 (b) Why?
 (c) Why might the pancreas be considered to be the second most important organ of digestion and not the stomach?

Name _____ Period _____ Date _____

Laboratory Activity #2— Student Laboratory Packet

Making Connections*A Laboratory Activity for the Living Environment***Discovering Connections**

As they make observations, scientists are always looking for patterns in the natural world. For instance researchers have observed that pregnant women who smoke cigarettes have a higher incidence of low-birthweight babies and that people with high-fat diets have a greater risk of developing heart disease. Many similar medical discoveries are a result of the patterns that can be observed when studying people and their lifestyles.

Discovering and explaining connections is one of the basic methods by which our knowledge of the world advances. It is what science is all about! Sometimes the connections are not what we expect or would predict, and sometimes we may have a hard time explaining the connections. Nevertheless, that is how science makes progress.

In this part of the laboratory activity, you will make a few observations about yourself and your classmates; then you will look for patterns or connections.

Safety.

Safety is important during any laboratory activity. Although no dangerous chemicals or heat sources are used in this investigation, be sure you are careful and behave responsibly.

Another concern is health. If you have health reasons for not performing the exercises called for in this activity, tell your teacher so that other arrangements can be made for you to successfully complete the investigation. If you are excused from gym class for medical reasons, for example, or if you have asthma, tell your teacher about it before beginning the laboratory activity.

Important Note: Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. Later you will need to transfer your answers to a separate Student Answer Packet. Your teacher will use that packet in grading your work, and the school will retain it as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.





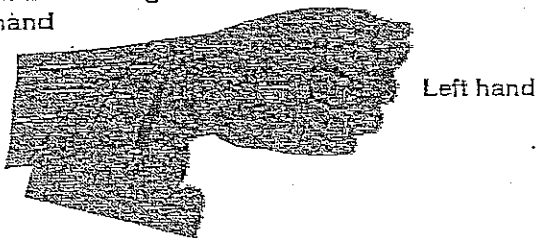
Part A. Looking for Patterns

A1. What Is Your Pulse Rate?

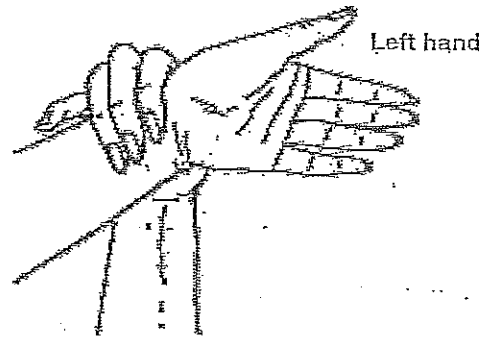
Your pulse is a result of the expansion of blood vessels that occurs each time your heart beats to send a surge of blood through your body. You can feel certain blood vessels "pulse" as this happens. Two different ways to take your own pulse are illustrated below. Choose the one that works best for you. As you press lightly, you should feel the pulsing of the blood. If you cannot locate your pulse after a short time, ask your teacher for help.

Two Methods of Taking Your Own Pulse

Index and middle fingers
of right hand



Left hand



Your pulse rate is a measure of how many times a minute your heart beats. Count the number of pulses you can feel in 20 seconds. Record the number below and then multiply it by 3 to determine how many times your heart beats in 60 seconds. Wait a minute and measure your pulse again. Wait another minute and measure your pulse a third time.

- Record your pulse rates for three trials below:

Trial 1 (20-second count) _____ X 3 = _____ per minute

Trial 2 (20-second count) _____ X 3 = _____ per minute

Trial 3 (20-second count) _____ X 3 = _____ per minute

Your pulse rate should be about the same each time. For accuracy, it is often better to take two or three readings, about a minute apart, and average them.

- Calculate and record your average pulse rate per minute: _____
- Record your average pulse rate on the board or on a transparency provided by your teacher so that everyone can see the pulse-rate data for the entire class.



Complete a Data Table

Use the average pulse rate for each student in the class to complete the data table below.

Class Results: Average Pulse Rates

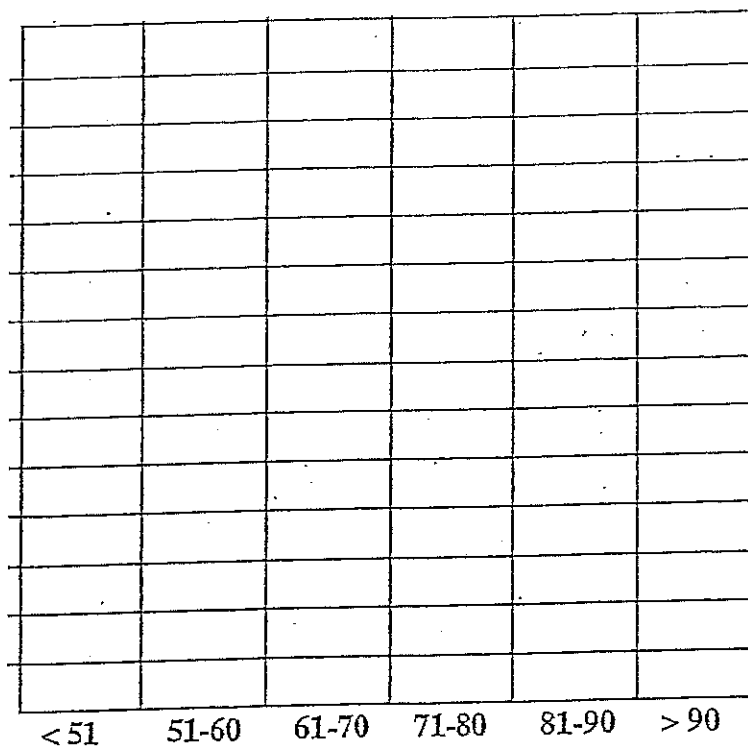
Pulse rate per minute (range of averages)	< 51	51-60	61-70	71-80	81-90	> 90
Number of students in this range						

Prepare a Histogram

Use the information in the data table to prepare a histogram of the class results. Use the grid below.

- Provide a title for the histogram.
- Label the vertical axis and mark an appropriate scale on the vertical axis.
- When you have determined the height of each column, shade in the vertical bars.

Histogram Title: _____



Average Pulse Rate Range



Answer the Following Questions

Do you see a pattern to the class data? _____ If so, what is it? If not, explain why you think a pattern does not exist.

A question that someone might ask about pulse rate is, "Is there a connection between height and pulse rate?" Based on the information obtained from this activity, can you tell if there is a connection between a person's height and the person's average pulse rate? _____ If so, explain the relationship and how you can tell it exists. If not, what additional data would you need to collect to find out if there is a connection?

State another question that someone might ask about pulse rate that could be answered by doing an experiment.

Some people have suggested that someone's pulse rate will increase if he or she becomes more active. Try this: Once you have found your resting pulse rate, run in place for one minute. As an alternative, you can dance or do knee bends, jumping jacks, or push-ups.

Did your pulse rate increase? _____ Ask four classmates if they got similar results. Did their pulse rates increase after exercise? _____

Pulse rates increase for most people after exercise. Explain why this connection between pulse rate and activity makes sense.



A2. How Does Fatigue Affect Muscle Performance?

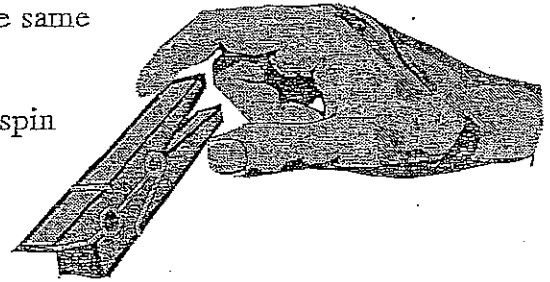
A condition known as *muscle fatigue* occurs when certain waste products of muscle cell activity build up in the cells. Until these waste chemicals are removed, the fatigue will continue.

Do the Following Activity

Hold a spring-type clothespin between your thumb and index finger. Pinch the ends together completely (until the two ends touch) and release them. Do this as rapidly as possible for one minute. Record the number of times you could squeeze the clothespin in one minute: _____

Try the activity again, doing it the same way and using the same two fingers as before.

Record the number of times you could squeeze the clothespin the second time: _____



Answer the Following Questions

Some people are able to squeeze the clothespin more times in a minute than others. Suggest a possible explanation for this.

Could you do as many in a minute the second time as you could do the first time? _____

Provide a biological explanation for these results.



Part A. Questions (*Answer each of the following questions in the spaces provided. You will need to turn in your final answers in a separate answer packet.*)

1. What does an increased pulse rate indicate about the heart rate and flow of blood in someone's body?

2. When muscles are active, cells use nutrients and oxygen at a higher rate and produce waste chemicals and heat more rapidly. Describe how the interaction of two or more body systems helps to maintain homeostasis during periods of high muscle activity. (Be sure to identify the two systems you refer to in your answer.)

3. A student in your class suggests that when most people watch exciting sporting events on television, their pulse rates increase. What is a reliable way to find out if this statement is correct?

4. What specific evidence would you need in order to determine if what the student suggests in question #3 can be supported?

5. If you wanted to increase your clothespin-squeezing rate, would you suggest exercising or resting before you did it? Explain why you think your choice is the correct one.



Part B. Investigating Claims

You hear many claims made every day. Advertisers make claims about the usefulness or effectiveness of their products. Your friend may claim to be able to do something that you do not think he or she can really do. Do you believe all the claims that people make? Have you ever bought a product based on a claim made in an advertisement, only to find that the product did not work as you expected it to?

When does a *claim* become a *fact*? Scientists look for evidence to support or refute a claim. Evidence can help you determine which claims are facts and which are opinions or even misrepresentations. For example, if one of your classmates claims to be the fastest runner in the class, you could gather evidence by holding a series of races. If your classmate's claim is true, that person should win all of the races. If another individual wins the races, your classmate's claim was simply an opinion not supported by the evidence.

In this part of the laboratory activity, you will conduct an investigation to determine which of two opposing claims can be supported with evidence. First read the section below. It describes two opposing claims. Then investigate to see which claim (if either) is supported.

Conflicting Claims About the Effect of Exercise on the Rate of Clothespin Squeezing

Student A claims that a person will be able to squeeze a clothespin more times in a minute if the person exercises first. Student A suggests that exercising produces a faster pulse rate, which indicates that the blood is getting to the muscles faster.

Student B claims that a person will be able to squeeze the clothespin more times in a minute if the person does *not* exercise first. Student B suggests that exercise takes energy away from the muscles, and a person who has been resting will have more energy.

Which of the two students do you agree with? _____ How could you find out for sure which claim is correct?

Design an Experiment

You must now design and conduct a controlled experiment to gather evidence that will determine which of the two claims is correct. Use the information on the next page to help you design your controlled experiment. Be sure your experimental methods will provide enough data upon which to base a valid conclusion. You will have to conduct several trials.

Guidelines for Designing a Controlled Experiment

Scientists follow certain guidelines when they conduct and report on a controlled experiment. These are provided below. As you work through this section to design your experiment, make notes as you go along. Your notes will become the outline for your investigation, and you can use them to prepare a final version at the end.

1. Determine the question you are trying to answer. The question should be directly related to what you want to find out. For example, if you want to know whether or not light intensity affects tomato seed germination (the emergence of a plant from the seed), you might ask, "Does light intensity affect tomato seed germination?"

Write in your notes the question you will be attempting to answer.

2. Formulate the hypothesis you will be testing with your experiment. The *hypothesis* is a tentative statement about the expected relationship between the variables. This statement must be written in a way that allows the relationship to be tested. It often suggests that there is a connection between two factors. For example, "Light intensity will influence the germination of tomato seeds."

Write in your notes the hypothesis you will be testing.

3. Formulate a title for your investigation. A title addresses specifically what is being investigated. The title should be a statement in the form of "The effect of...on..." You should specify the organism(s) you are using as well. For example, "The effect of light intensity on seed germination in tomato plants."

Write the title of your experiment in your notes.

- 171
5. Design one or more data tables that you will use to record the data as it is collected. Your data table(s) should also have sections for summarizing or averaging the data, as appropriate. Your data table(s) must be designed and finalized before you begin the experiment. *Sketch in your notes the data table(s) you plan to use. Be sure to include appropriate headings and units.*
-
-
-



Organization of the Final Report

When you are finished, organize your data and determine what the data “tells you.” Also, review what you did and think about whether or not some procedures should have been done differently to give you more reliable results. Your final report should have the following sections:

- **Title** — Use your notes from the previous section. (Refer to Guideline 3.)
- **Hypothesis** — Use your notes from the previous section. (Refer to Guideline 2.)
- **Methods and Materials** — Describe the materials (what you used) and procedures (what you did) in your experiment. This may be done in the form of a list, a paragraph, or a combination of both. Use your notes from the previous section to guide you in this. (Refer to Guidelines 4 and 6.) Be sure to identify the dependent and independent variables.
- **Data Collected** — Include your completed data table(s) and, if appropriate, a graph or graphs to summarize the data for easier understanding of what you found.
- **Discussion and Conclusions** — These will relate back to the title and hypothesis for the investigation. Be sure to note whether your data supports or does not support your hypothesis. You also need to include an explanation of how or why this conclusion follows from the data you collected.
- **Suggestions for Improvement** — Discuss any possible sources of error that may make your data less reliable. Include a discussion of controlling the variables when investigations involve human subjects. State three additional variables that may have influenced the outcome of your experiment.
- **Suggestions for Further Research** — Nearly any experiment that is done produces new questions that could be answered with new investigations. Include two suggestions for other investigations that could be done or additional data that needs to be collected to further support your findings or to answer any new questions that came up during the experiment.

Note: You will need to make two copies of the report—one to hand in and one for exam review.

Prepare To Present Your Research to the Class

Just as scientists must always defend their claims and conclusions to their peers, you should be prepared to report on and defend your findings before the class. If you are chosen to do a presentation to the class, you should be able to address each of the sections of the final report and to answer questions about your data and conclusions. You should prepare some visual aids to make the presentation clear and understandable.

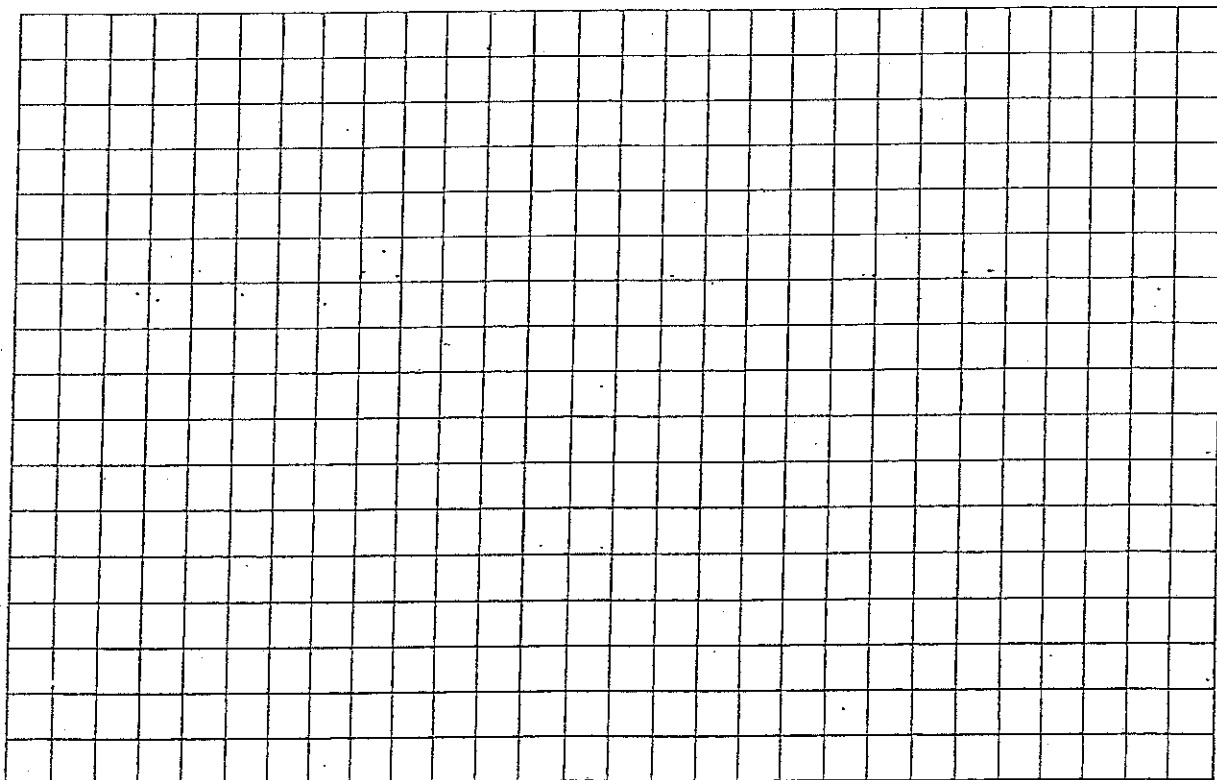
Title: _____

Hypothesis: _____

Materials:

Method/Procedure:

Data:



Discussion/Conclusion:

Suggestions for Improvement:

Suggestions for Further Research:

Name _____

Date _____

Thyroid Gland

68

The thyroid gland is one of the endocrine glands present in the human body. It produces a hormone called thyroxine. Thyroxine controls the metabolic rate of body cells. The amount of thyroxine produced by your thyroid depends on and is controlled by the amounts of two other hormones present in the body. Thyrotropin-releasing factor (TRF) is produced by an area of the brain called the hypothalamus. Thyroid-stimulating hormone (TSH) is a hormone made by the pituitary gland. These three chemicals interact in maintaining a suitable thyroxine level.

In this investigation, you will

- label drawings showing location of the body parts involved in thyroxine regulation and the hormones produced.
- complete drawings showing inhibitory and stimulatory effects.
- observe thyroid tissue under the microscope.

Materials



microscope

prepared slide of normal thyroid gland

prepared slide of thyroid gland with goiter

Procedure

Part A. Identifying Glands and Hormones Related to Thyroid Action

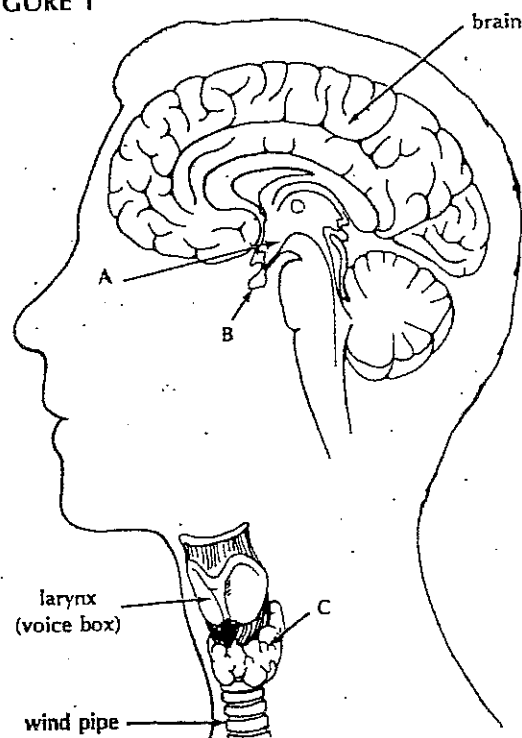
- Look at Figure 1. Letter A shows the location of the hypothalamus. Letter B shows the location of the pituitary gland. Letter C shows the location of the thyroid gland.

The hormones produced by these three glands interact in the following manner to maintain the correct thyroxine level. TRF from the hypothalamus stimulates the pituitary gland to form and release TSH. TSH stimulates the thyroid to form and release thyroxine. Thyroxine in turn influences the production of TRF.

- Draw arrows on Figure 1 to indicate these three hormones. The arrow should point from the producing gland to the influenced gland.

- Label each arrow with the name of the hormone it represents.

FIGURE 1



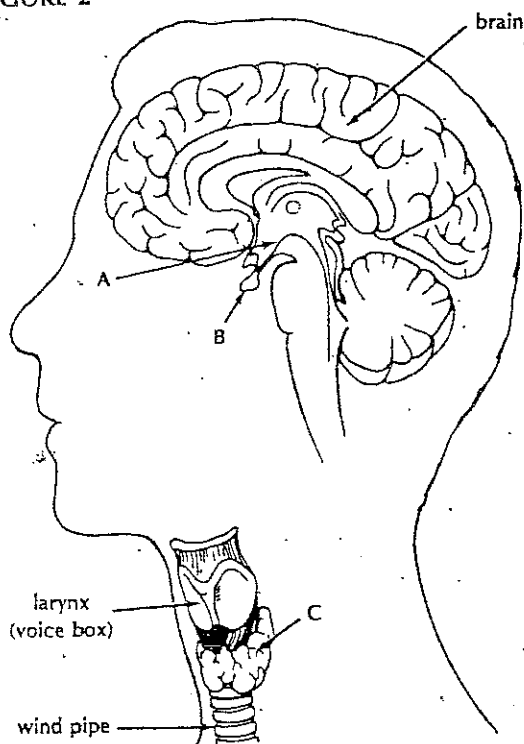
Part B. Inhibitory and Stimulatory Effects of These Hormones

The release of the correct amount of thyroxine your body is regulated by a constant "turning on and off" of the thyroid gland. This "on" and "off" action of the thyroid is self-regulating. As the amount of thyroxine increases in your body, it uses the hypothalamus to slow its production of TRF. This "turning off" of the hypothalamus uses an inhibitory effect on the production of thyroxine.

What hormone is no longer produced by the hypothalamus when it is "turned off"? _____
If TRF is no longer produced, what happens to the production of TSH? _____
What happens to thyroxine production when TSH stops? _____

Use Figure 2 to show the events that lead to the inhibition of thyroxine production. Use arrows of different widths to indicate the amounts of each hormone present when the hypothalamus is "turned off." HINT: Remember, thyroxine production must be high in order to trigger the inhibitory effect.

FIGURE 2



• Label the arrows with the names of the hormones and each hormone's relative amount. Use the words *increases* and *decreases*.

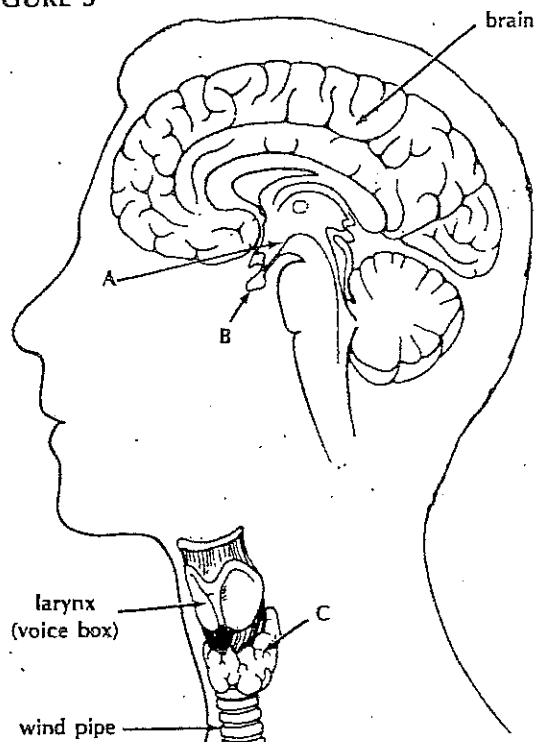
As the amount of thyroxine decreases in your body due to the events just described, the hypothalamus resumes its production of TRF. This "turning on" of the hypothalamus results in a stimulatory effect on the production of thyroxine.

4. What hormone is again produced if the hypothalamus is "turned on"? _____
5. What happens to the pituitary when the hypothalamus is "turned on"? _____
6. What happens to thyroxine production when TSH production begins again? _____

• Use Figure 3 to show the events that lead to increased thyroxine production. Use arrows of different widths to indicate the amounts of each hormone present when the hypothalamus "turns on." HINT: Remember, thyroxine production must be low in order to trigger the stimulatory effect.

• Label the arrows with the names of the hormones and each hormone's relative amount. Use the words *increases* and *decreases*.

FIGURE 3



Date _____

Name _____

FIGURE 4

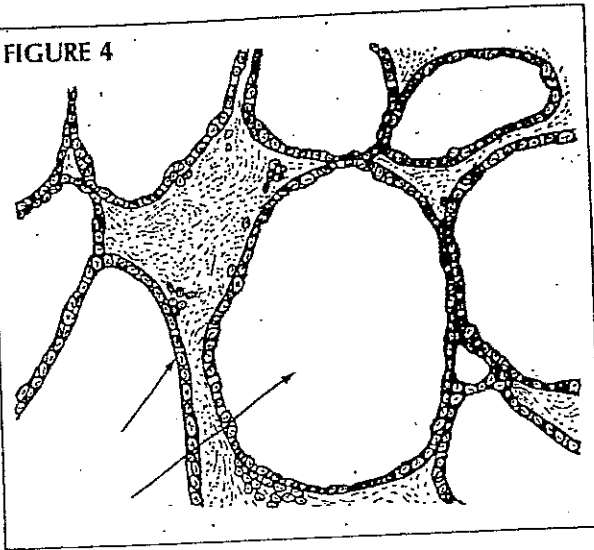
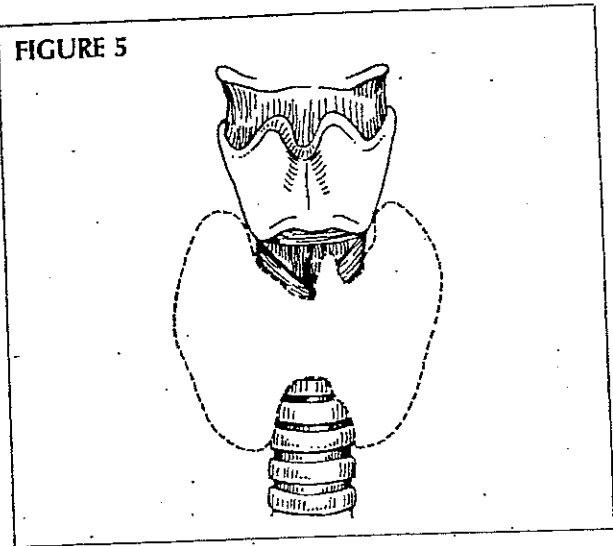


FIGURE 5



Part C. Observing Thyroid Tissue

- Examine a prepared slide of the thyroid under low power.
- Identify and label the following areas on Figure 4:
 - (a) *colloid*—noncellular, liquid areas of thyroid.
 - (b) *follicle*—areas or patches in thyroid that surround colloid; no specific shape or size.

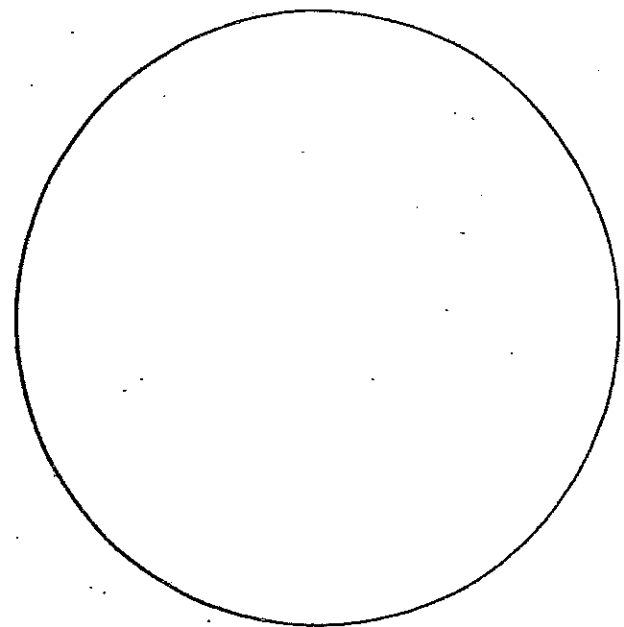
Part D. Abnormal Thyroid Functioning

Iodine is an important part of thyroxine. Iodine must be present in order for thyroxine to form. The iodine is supplied to the body by food. Lack of iodine results in thyroxine deficiency.

7. If the amount of thyroxine is reduced, which figure, Figure 2 or 3, would show the results that take place? _____

8. Explain. _____

A supply of TRH and TSH with no inhibitor causes the thyroid gland to enlarge. Recall from Part B that TSH stimulates the thyroid to produce more thyroxine. TSH continues to stimulate the thyroid, but no thyroxine is formed. This constant stimulation results in an increase in the size of the colloid areas of the gland. This condition is called a goiter.



thyroid tissue
affected by goiter

- Under low power, examine a prepared slide of a thyroid gland affected with goiter.

- Diagram the appearance of the affected tissue in the space provided. Label *colloid* and *follicle*.

- Diagram on Figure 5 what the shape of a thyroid affected with goiter might look like. NOTE: The normal outline of the thyroid is represented by dashed lines.

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Analysis

1. Name one hormone studied in this investigation produced by your

- (a) hypothalamus. _____
- (b) pituitary gland. _____
- (c) thyroid gland. _____

2. Define the following terms:

- (a) inhibitory effect. _____
- (b) stimulatory effect. _____
- (c) self-regulating. _____
- (d) goiter. _____

3. (a) Increased amounts of thyroxine can turn off the supply of thyroxine. Explain briefly how this inhibitory effect occurs. _____

(b) Decreased amounts of thyroxine can turn on the supply of thyroxine. Explain briefly how this stimulatory effect occurs. _____

4. What role does thyroxine play in the human body? (HINT: Reread introduction.) _____

5. Many people in the U.S. during the last century developed goiters. They lived primarily in the central part of the country away from the ocean coasts. Explain why goiters may have developed in these areas.

(NOTE: People along the oceans ate more seafood which contains iodine.) _____

6. Today, table salt is iodized, meaning that it has iodine added to it. Why is addition of iodine to salt a healthful practice, especially for those who do not eat seafood? _____

15-2 The Brain and Its Functions

The human brain is divided into three different parts. Each part is specialized. Each part has a job to perform that is different from the other parts. The brain is even more specialized in that specific brain sides control only specific body sides.

GOALS

In this exercise, you will:

- identify and label the three brain areas.
- determine the jobs of certain brain areas.
- match brain areas with their corresponding areas of body control.

KEYWORDS

Define the following keywords:

cerebellum _____

cerebrum _____

involuntary _____

medulla _____

voluntary _____

MATERIALS

#2 pencil colored pencils: red, green, blue, gray, and yellow

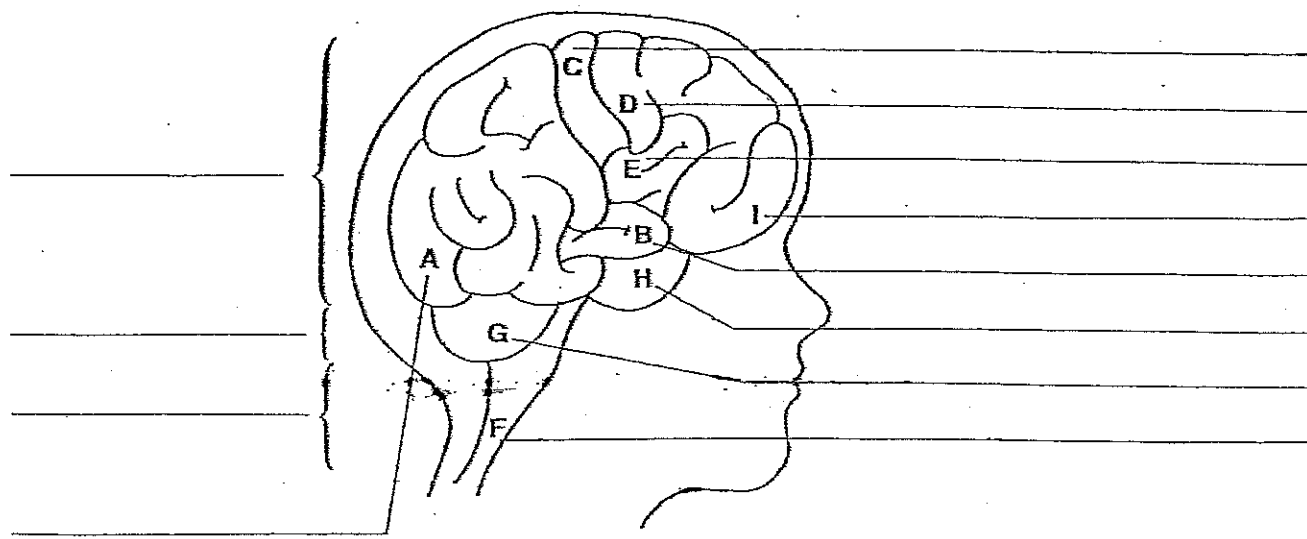
PROCEDURE

Part A. Control Areas of the Brain

- Examine Figure 1. This shows a side view of the human brain. Label the brackets correctly to show the brain's three parts or areas. Use the following labels: medulla, cerebrum, and cerebellum.
- Label the functions of certain brain parts by using the following labels:

A. vision center	F. heartbeat center
B. speech center	G. coordination center for body muscle
C. sensation of body pain	H. smell center
D. muscle control of body	I. personality center
E. hearing center	
- Still using Figure 1, color in the voluntary parts of the brain with a red pencil. Color the involuntary parts blue.

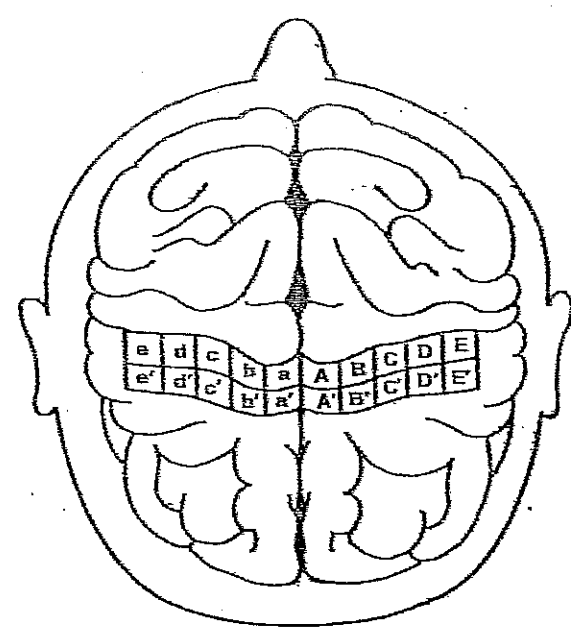
FIGURE 1. Side view of the human brain



Part B. How the Brain Controls the Body

1. Examine the top view of the cerebrum in Figure 2. Note that the cerebrum is divided into left and right sides. Each side has been marked for you.
2. Locate and examine the two front views of the body in Figure 3. Note that in these views the left and right sides are reversed (this is because they are front views). The body views are marked either "sensation of body pain" or "muscle control of body." Muscle control and body pain are controlled by certain brain areas. The brain area controlling this and the corresponding areas on the body are marked with similar letters.

FIGURE 2. The cerebrum



left side of cerebrum right side of cerebrum

3. Match the brain areas of Figure 2 with their corresponding body areas of Figure 3 by coloring in parts of the figures as follows:

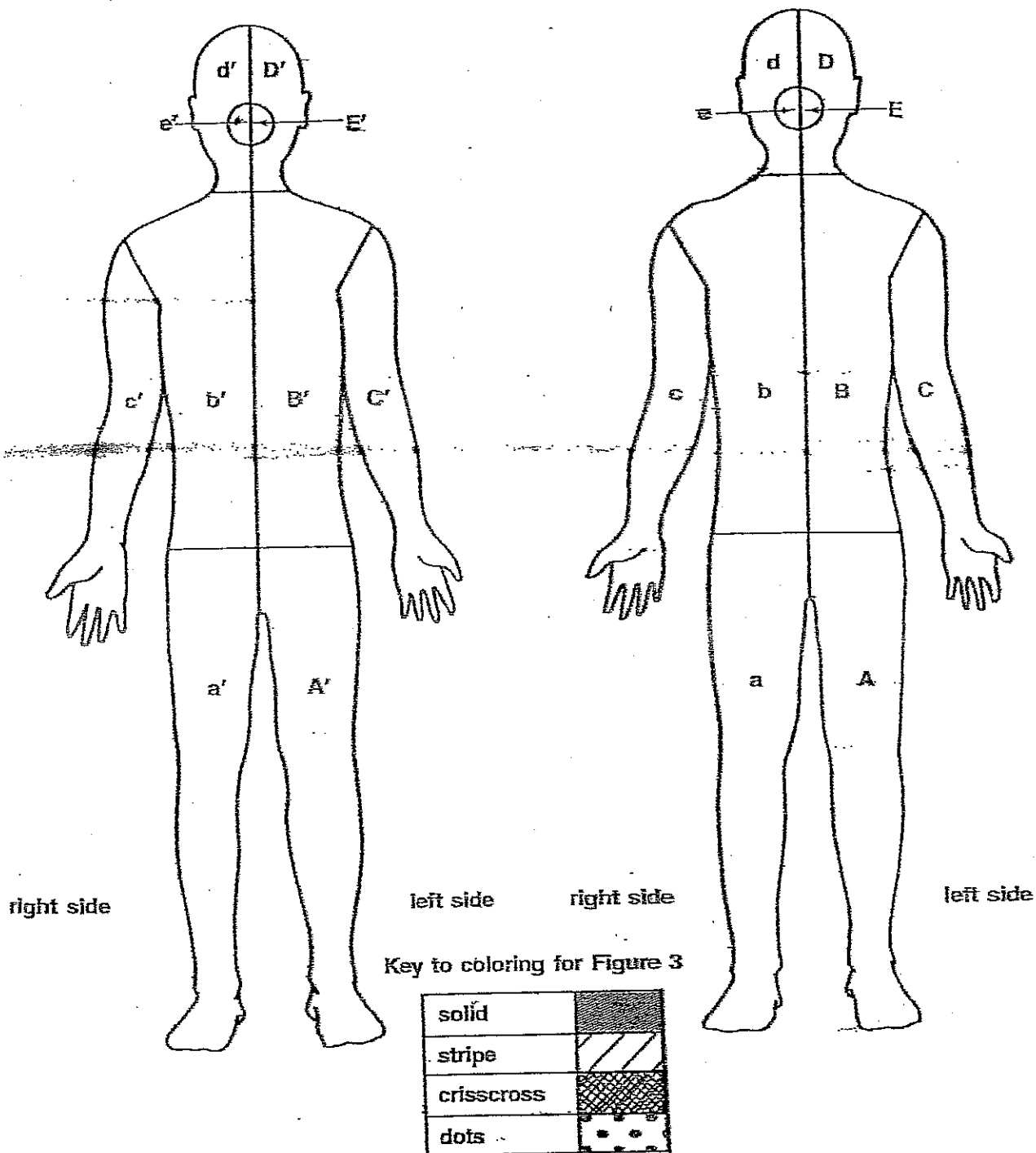
A-solid red	A'-stripe red	a-crisscross red	a'-dot red
B-solid blue	B'-stripe blue	b-crisscross blue	b'-dot blue
C-solid green	C'-stripe green	c-crisscross green	c'-dot green
D-solid yellow	D'-stripe yellow	d-crisscross yellow	d'-dot yellow
E-solid gray	E'-stripe gray	e-crisscross gray	e'-dot gray

Name _____ Class _____ Period _____

FIGURE 3. Front views of the human body

sensation of body pain

muscle control of body



QUESTIONS

1. Which brain area is the largest? _____
2. What side and functions are part of body areas

a. A-E? _____

b. a-e? _____

Laboratory Investigation

Mammals

18

The Most Intelligent Mammals

You may want to refer students to pages C120-C136 in the textbook for a general discussion of mammals.

Time required: 40 minutes

Background Information

Mammals have the most highly developed brains of all animals. The brains of many lower animals permit little, if any, learning. These animals respond to stimuli through inborn fixed behavior patterns such as reflexes and instincts. Such behaviors are not necessarily influenced by experience. Learning, on the other hand, leads to changes in behavior as the result of experience. In higher animals, this learning is not merely habit or trial-and-error behavior; rather, it involves reasoning. The ability to reason reaches its height in human behavior. Humans are the most intelligent mammals. In this investigation you will study human behavior.

Problem

Which tasks that humans perform are learned behaviors and which are unlearned? What roles do reflexes, conditioned responses, habits, trial-and-error learning, and reasoning play in human behavior?

Materials (per group)

paper and pencil
watch with second hand

Procedure

Part A Reflexes

1. A reflex is a simple automatic response to a stimulus. A reflex usually involves only part of the body. Working with a partner, you will alternate as subject and helper while you test two human reflexes. You will record the responses in Data Table 1.
2. Close your eyes and cover them with your hands. At the end of 1 minute, open your eyes while your partner watches your eyes closely. Record the response in Data Table 1.
3. Stand with your side to a wall. Hold your arm down at your side and slightly away from your body. Tightly press the back of your hand against the wall until your shoulder begins to ache. After 1 minute, step away from the wall while still holding your arm stiff. Record the response in Data Table 1.

Part B Conditioned Reflexes

1. Read the following instructions to your partner: "Each time I say 'Write,' I want you to make a tally mark on a sheet of paper. Then place your pencil in position to make the next mark."
2. Give the command to write several times in succession. For most of the commands, hit your pencil on the desk at the same time that you say the word "Write."
3. Occasionally, hit your pencil on the desk but do not give the command to write. Try this several times.

Part C Habits

1. Dictate the following passage to your partner while he or she writes it down. Dictate at a fairly rapid pace. "Habits are often useful in allowing routine activities to be carried out quickly. But most of us have some habits that we would like to break. Breaking a habit is not a simple thing to do."
2. Dictate the same passage again, but this time instruct your partner not to cross any t's or dot any i's. Record your data in Part C of Observations.

Part D Trial-and-Error Learning

1. Trial-and-error learning begins when an animal associates certain responses with favorable or unfavorable consequences. The animal then tries to repeat those behaviors that led to favorable results.
2. How quickly can you complete a path through Maze 1? Use a pencil to mark your path and have your partner time you. Record the time needed to complete the maze in Data Table 2.
3. Complete the rest of the mazes in succession, timing each one as you go. Cover each completed maze as you finish, so that you cannot look back at them. Record the times in Data Table 2.

Part E Reasoning

1. Reasoning is learning that involves thinking, judgment, and memory. Primates have the ability to reason: they are the most intelligent mammals.
2. Try your hand at the following problems that involve reasoning:
 - a. There are four separate equal-sized boxes, and inside each box there are two separate small boxes, and inside each of the small boxes, there are three even smaller boxes. What is the total number of boxes? Record your answer in Part E of Observations.
 - b. Figure 2 in Part E of Observations represents nine bears in a square enclosure at the zoo. Build two more square enclosures within this one so that each bear is in a pen by itself.
 - c. There are five girls: Maureen, Sue, Jill, Robin, and Pam. They are standing in a row but not necessarily in the order named. Neither Maureen nor Sue is next to Robin. Neither Sue nor Maureen is next to Pam. Neither Robin nor Sue is next to Jill. Pam is just to the right of Jill. Name the girls from left to right.

Observations

Part A

Record the results of your reflex experiments below.

DATA TABLE 1

Stimulus	Response
Light	
Pressure on arm muscle	

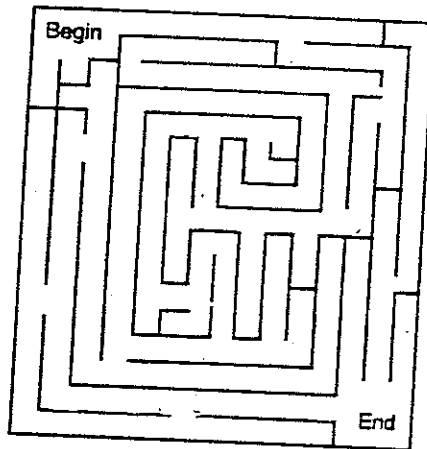
Part B

What happened when you hit the pencil on the desk (conditioned stimulus) but did not give the command to write?

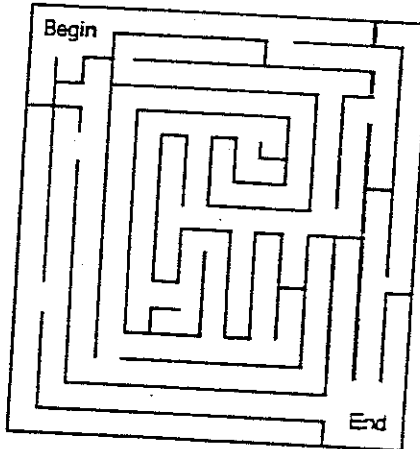
Part C

How many times did you cross t's or dot i's in the second passage? _____

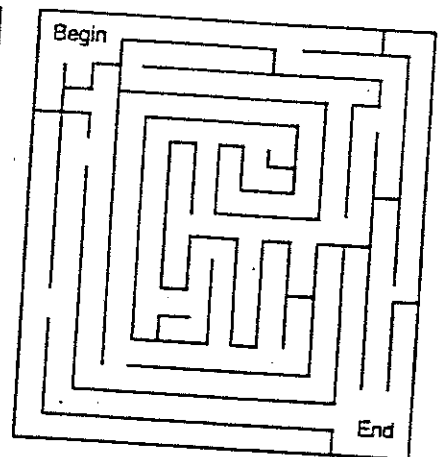
Part D



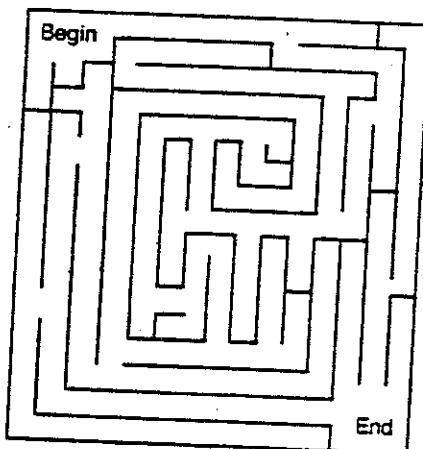
Maze 1



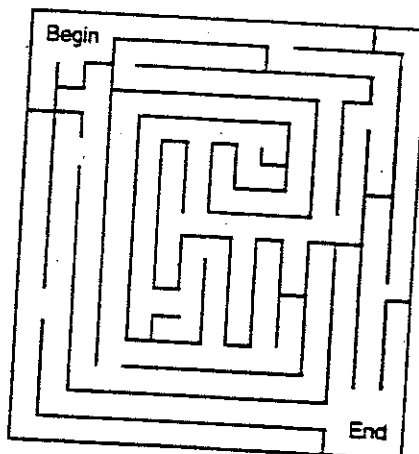
Maze 2



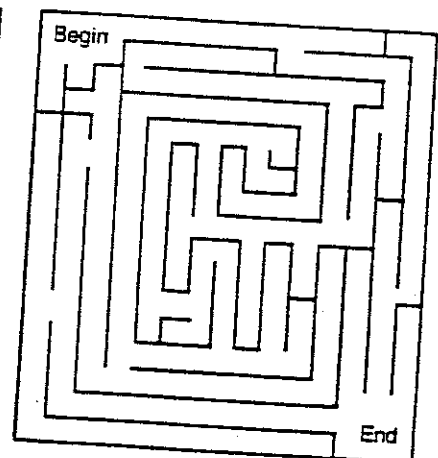
Maze 3



Maze 4



Maze 5



Maze 6

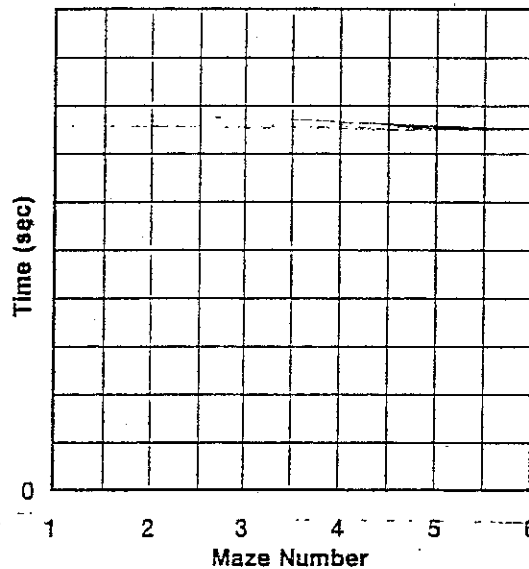
Figure 1

1. Record the results of your maze experiment below.

DATA TABLE 2

Maze Number	Time (sec)
1	
2	
3	
4	
5	
6	

2. Construct a graph of your results. Graph will vary according to answers obtained.



Part E

1. Write your answers to the reasoning problems below.

a. How many boxes are there? _____

b.

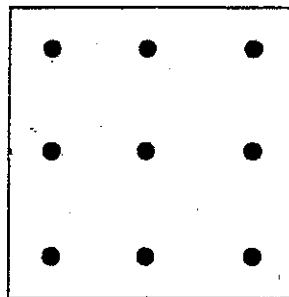


Figure 2

c. Name the girls from left to right: _____

Analysis and Conclusions

Part A

1. Name other reflexes in humans. _____

2. How are these reflexes useful? _____
3. Is a reflex learned or unlearned behavior? _____

Part B

1. Were you able to condition or "fool" your partner into always making a mark on the paper when you hit your pencil on the desk and didn't give the command to write?

Explain why you think you were or were not able to do so. _____

2. Is the response to the pencil tap learned or unlearned behavior?

Part C

Is a habit learned or unlearned behavior? _____

Part D

Did any learning take place during this part of the investigation? Give evidence to support your answer. _____

Part E

Which order of organisms are the most intelligent?

Critical Thinking and Application

1. How is the blinking response a protective reflex?

2. Describe a situation in which you learned through trial and error.

3. Why are some habits useful to you whereas others are not?

Going Further

Cover columns B, C, and D with a piece of paper. Study the words in column A for 1 minute. Then write down as many of the words as you can remember. Record your score. Follow the same procedure for column B, then C, and then D.

A	B	C	D
Zop	House	Purple	Sally
Wab	Tree	Gold	and
Dod	Shoe	Red	Bob
Jav	Sock	Blue	went
Cug	Dog	Yellow	to
Sor	Floor	Green	the
Duz	Rock	Orange	football
Tig	Father	Black	game
Wek	Candy	White	last
Foy	Picture	Pink	night

Which column was easiest to remember? How do you explain the difference in your ability to learn the words in each column? How can this experiment help you in studying?

Name: _____ Date: _____

Nerve Wracker: Testing Your Reflexes and Reactions

Background

You have probably touched a hot stove or sharp object and pulled your hand away before realizing what had happened. This fast and automatic reaction to a stimulus is a reflex action. Some reflexes prevent injury to the body. For example, the withdrawal reflex that allows you to remove your hand from the hot stove before you even feel a sensation of heat helps to prevent a severe burn. Reflexes also control automatic activities in the body, such as beating of the heart, breathing, gagging and stomach movements.

In the reflex arc, or pathway, of the simple withdrawal reflex described above, a sensory neuron carries impulses from the skin to the spinal cord, where it synapses with an interneuron. The interneuron synapses with a motor neuron. Impulses carried by the motor neuron stimulate the appropriate muscles to withdraw the affected body part. All this happens in a fraction of a second.

In nonreflex responses, impulses travel to the brain, where they are interpreted and a proper response initiated. The time required for the brain to receive the impulses, interpret them, and initiate a response is much longer than the time required for a reflex arc which involves only the spinal cord.

A person's reaction time is a measure of how quickly he or she can perceive a stimulus and react to it. Reaction time is important in operating vehicles and machinery, in sports, and in many everyday activities. Reaction time may be increased by fatigue, drugs and distraction.

Objectives

In this lab you will:

1. Demonstrate some human reflexes.
2. Measure your reaction time.

Materials

Meter Stick
Calculator
Clear Plastic Sheet

Procedure

Part 1. Reflexes

Work in pairs, alternating as subject and experimenter.

1. The subject should sit on a chair with one leg crossed over the other. The top leg must be free to swing. With the side of the hand the experimenter should tap the subject's knee on the tendon just below the kneecap. NOT TOO HARD!!!!. It may take several taps before the proper part of the tendon is stimulated.
 - a. Describe the response of the leg

2. Repeat Step 1, but this time the top leg of the subject should be held out straight.

- b. Describe the response of the leg

- c. In which leg position is the response the greatest?

3. Switch roles and repeat Steps 1 and 2

4. The subject should close and cover his or her eyes for at least 1 minute. At the end of the minute, the experimenter should watch the subject's pupils as the eyes open.

- d. Describe the response of the iris and its effect of the pupil.

5. Switch roles and repeat Step 4.

6. The subject should hold a clear plastic sheet in front of his/her face. The experimenter should toss a crumpled sheet of paper at the subject to try to make him/her blink.

- e. Describe the response of the subject's eyes.

7. Switch roles and repeat Step 8.

Part 2. Reaction Time

1. The subject should rest his or her elbow on the lab table, with the arm extending over the side. The experimenter should hold a meter stick in the air, with the 0-cm line between the subject's index finger and thumb. The experimenter should drop the meter stick and the subject should catch it between the index finger and thumb as quickly as possible. Record the distance the meter stick fell in the Data table under column A.

2. Repeat Step 1 four more times.

3. Switch roles and repeat Steps 1 and 2.

4. Determine the average distance the meter stick fell by adding the measurements from the five trials and dividing by 5.

5. Record the average distance in the Data Table under Column A.

The time it takes for an object to fall a certain distance can be found by the formula:

$$t = \sqrt{\frac{2d}{a}}$$

t = reaction time in seconds

d = distance the meter stick falls in centimeters

a = acceleration due to gravity = 980 cm/s^2

6. Determine your reaction time by using the above formula. Use the average distance determined in Step 4.
7. Record your reaction time in the Data Table under Column A.
8. Repeat the experiment, this time the subject should close his/her eyes. Before the experimenter releases the meter stick he/ her should say "GO". The subject should try to catch the stick as quickly as possible. Record the distance the meter stick fell in the Data Table under Column B.
9. Repeat Step 8, four more times.
10. Switch roles and repeat Steps 8 and 9.
11. Determine the average distance the meter stick fell by adding the measurements from the five trials and dividing by 5.
12. Record the average distance in the Data Table under Column B.
13. Calculate and record your reaction time in the Data Table under Column B.
14. Repeat the experiment, this time the subject should use the opposite hand. The experimenter should drop the meter stick and the subject should catch it between the index finger and thumb as quickly as possible. Record the distance the meter stick fell in the Data table under Column C.
15. Repeat Step 14 four more times.
16. Switch roles and repeat Steps 14 and 15.
17. Determine the average distance the meter stick fell by adding the measurements from the five trials and dividing by 5.
18. Record the average distance in the Data Table under Column C.
19. Calculate and record your reaction time in the Data Table under Column C.

20. Identify and record the stimulus in each experiment in the Data Table.
21. Rate the experiment according to speed. (Quickest reaction time should be #1)

Analysis

1. How is the iris-pupil response to light a reflex that may protect you?

2. How is the blinking response a protective reflex?

3. Which experiment produced the quickest reaction time? Explain your results.

4. Name three sports and three occupations in which reaction time is important.

5. Give an example of how distraction could slow down reaction time.

6. Considering your experiments with reaction time, do you think a subject could catch a dollar bill folded lengthwise and dropped through his/her fingers? Test your prediction

- 7a. Explain the pathway an impulse travels from the moment you detect the movement of the stick (starting with your eye) until you grip the stick with your hand. BE SPECIFIC!!!!

- 7b. How is this pathway different from a reflex-arc?

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NerveWracker Data Table

	<u>Column A</u> Normal hand Eyes Open	<u>Column B</u> Normal Hand Eyes Closed Partner says "GO"	<u>Column C</u> Opposite Hand Eyes Open
Trial 1			
Trial 2			
Trial 3			
Trial 4			
Trial 5			
(Average)			
Reaction Time			
Stimulus			
Rate Reaction Times (1, 2, 3)			

Name _____ Class _____ Period _____

14-2 How Do Male and Female Skeletons Differ?

A skeleton is found. A doctor reports to the police that it is an adult male skeleton. How could the doctor determine if the skeleton were from a male or a female?

Several differences exist between the skeleton of a male and that of a female. The main difference is in the shape of the pelvis. The female usually has a wider pelvis. Let's see how some measurements compare.

GOALS

In this exercise, you will:

1. examine and measure diagrams of a male and female pelvis.
2. determine how these measurements differ in male and female pelvises.
3. use your data to determine if a third pelvis is male or female.

KEYWORDS

Define the following keywords:

femur _____

pelvis _____

sacrum _____

skeleton _____

MATERIALS

metric ruler

PROCEDURE

1. Examine Figure 1. Figure 1a is the pelvis from an adult male. Figure 1b is the pelvis from an adult female.
2. Measure the length (in millimeters) of the following dashed lines on Figures 1a and 1b: lines *a*, *b*, *c*, and *d*.
3. Record these numbers in Table 1. Note that lines *b* and *c* are part of the sacrum bone (shaded). This bone is found at the back of the pelvis and does not block the pelvis opening. It does, however, appear to block the opening in the figures.

16

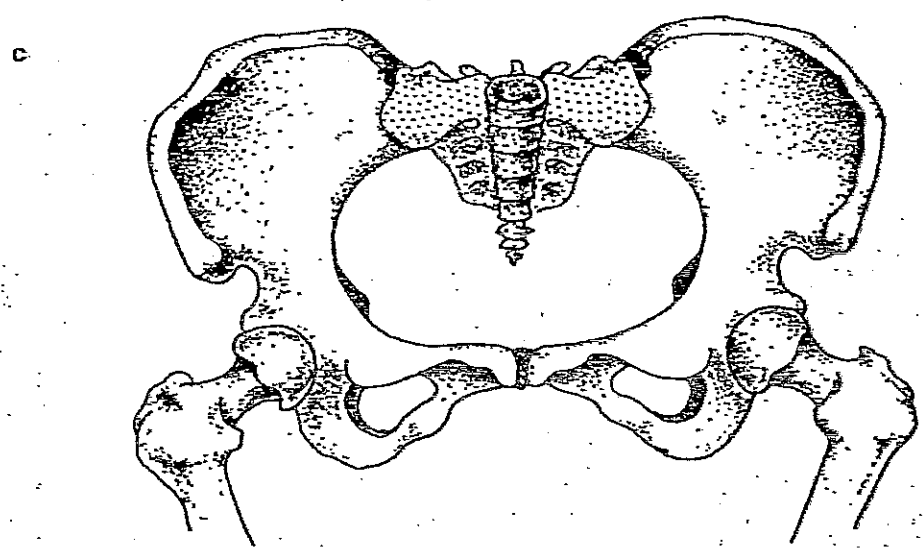
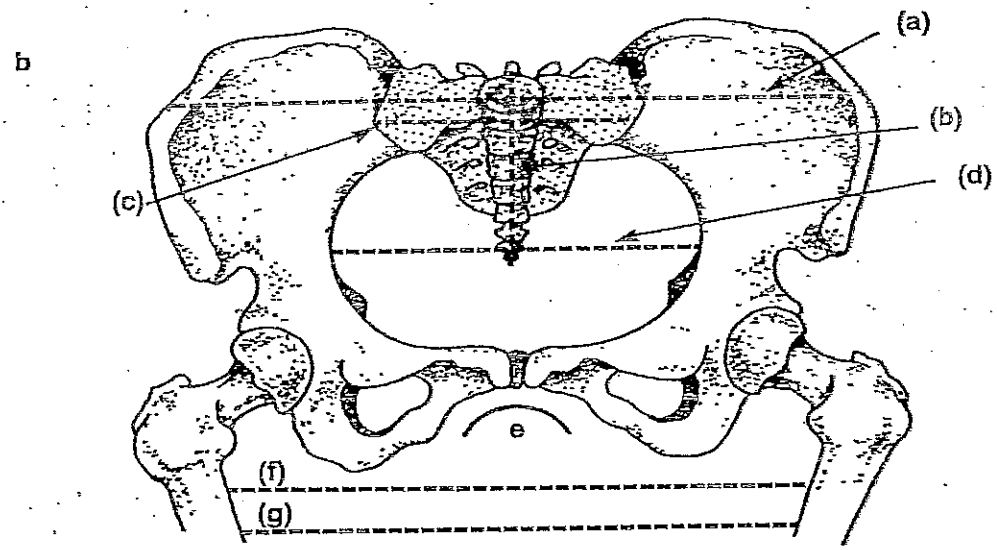
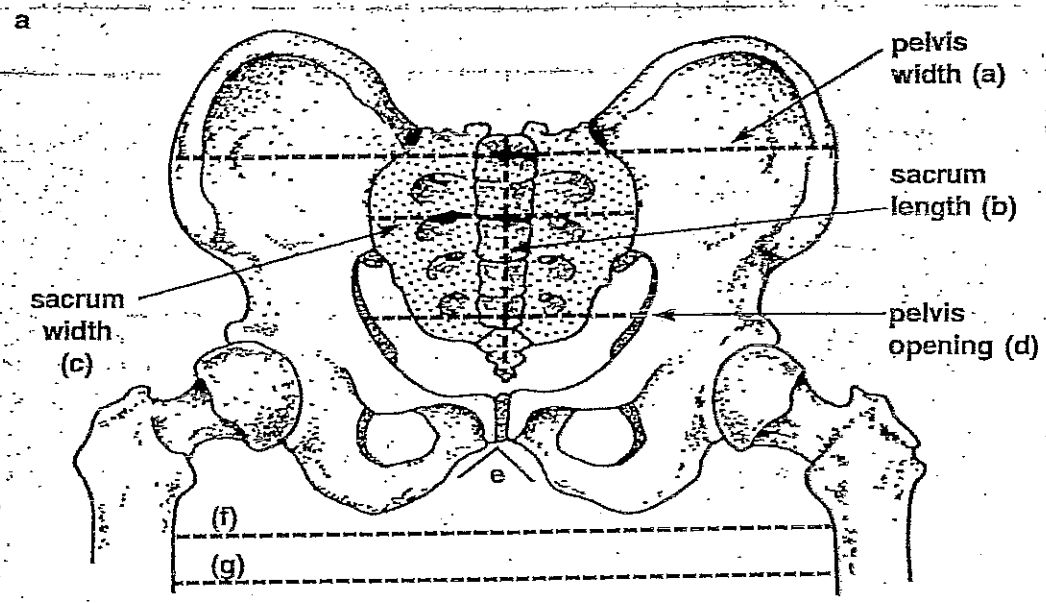


FIGURE 1. Human pelvises

Name _____ Class _____ Period _____

4. Locate letter *e* on Figures 1a and 1b. Note that the bottom of each pelvis is either round or pointed at this location. Record in Table 1 if the bottom is pointed or round.
5. Measure and record in Table 1 the lengths of dotted lines *f* and *g* on Figures 1a and 1b. If the femur bones hang *straight down*, the lengths of lines *f* and *g* will be the same. If the femur bones *slant inward*, the lengths of lines *f* and *g* will differ. This position of femur bones (thigh bones) provide a clue as to whether the skeleton is male or female.
6. Record your measurements and position of the femurs in Table 1.
Note that now you have a way of telling male from female skeletons by using all the data in Table 1.
7. Measure and record all the lengths of the pelvis and femur parts in Figure 1c just as you did for Figures 1a and 1b. The dashed lines are not included in the figure. Record your data in Table 1.
8. Indicate in Table 1 if Figure 1c represents a male or female skeleton.

Table 1. Pelvic Bone Measurements

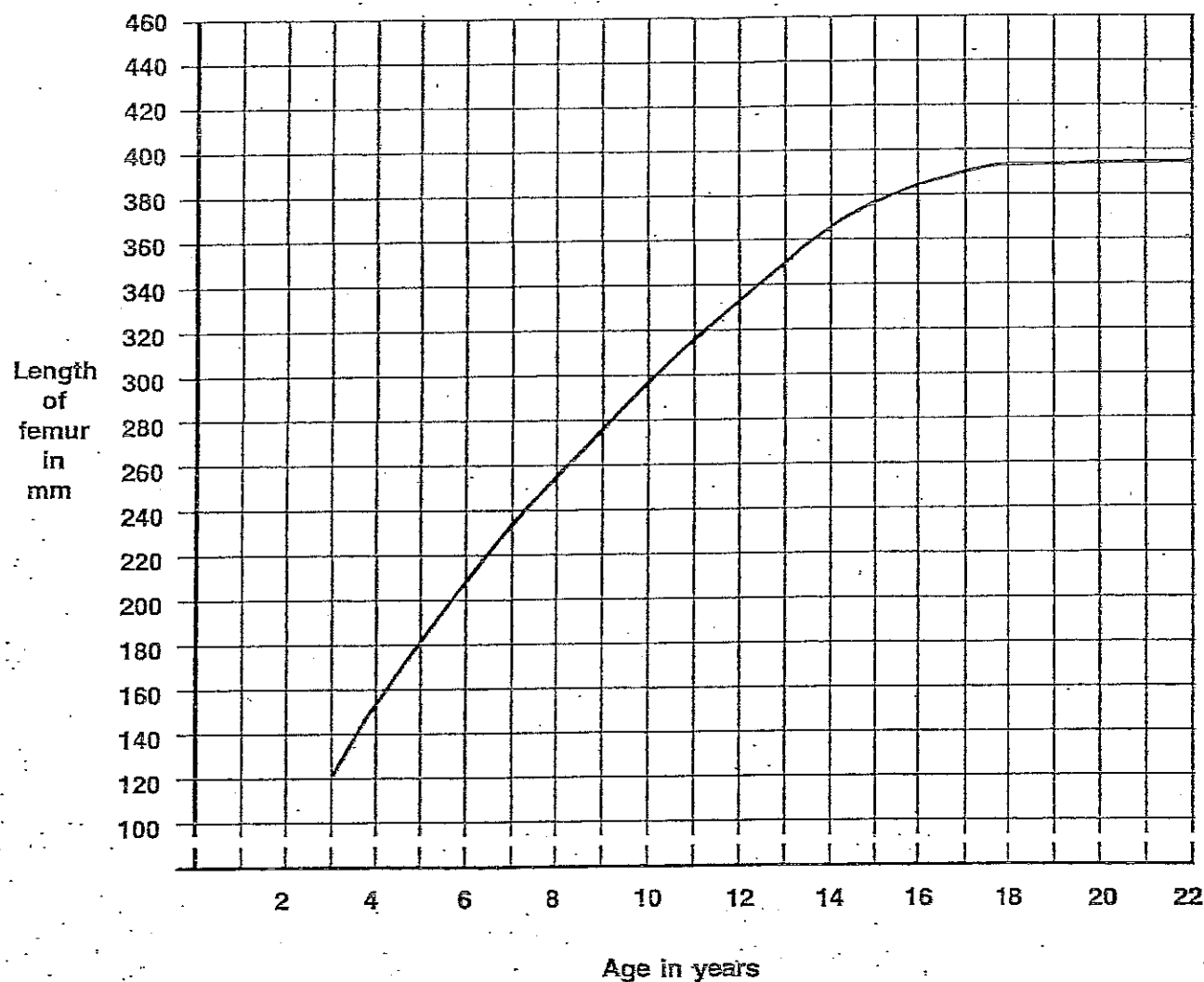
Figure	Sex	Pelvis width line a	Sacrum length line b	Sacrum width line c	Pelvis opening line d	Bottom shape	Line f	Line g	Position of femurs
1a	Male								
1b	Female								
1c									

QUESTIONS

1. Explain how each of the following differs in adult male and adult female skeletons:
 - a. pelvis width _____
 - b. sacrum _____
 - c. pelvis opening width _____
 - d. bottom shape of pelvis _____
 - e. position of femur bones _____
2. Figure 1c is from a _____ (male or female.) List three things that helped you with your answer. _____

3. The approximate age of a skeleton can be told by measuring the length of the femur bone. The graph shown in Figure 4 gives you these measurements. By using this graph, determine the approximate age of a skeleton whose femur measures
- a. 200 millimeters. _____
 - b. 300 millimeters. _____
 - c. 350 millimeters. _____
4. Explain why the graph in Figure 2 cannot be used to determine the age beyond 18 years. _____

FIGURE 2. Age of human skeletons



Name _____

Date _____

Skeletal Muscles

71

Every time you move part of your body, the action of muscles is required. Muscles are responsible for moving bones. It is this bone movement that results in your being able to walk, run, lift objects, or even nod your head yes and no. Muscle tissue is able to allow these movements because of its ability to shorten in length.

In this investigation, you will

- (a) examine a slide of skeletal muscle under the microscope.
- (b) compare diagrams of arm and leg muscles to determine how the shortening of muscles results in body movement.
- (c) prepare a muscle model to demonstrate the way that muscle shortening results in body movement.

Materials



microscope
prepared slide of skeletal muscle
string (2 pieces, each 20 cm long)

poster board
paper punch
metal fastener

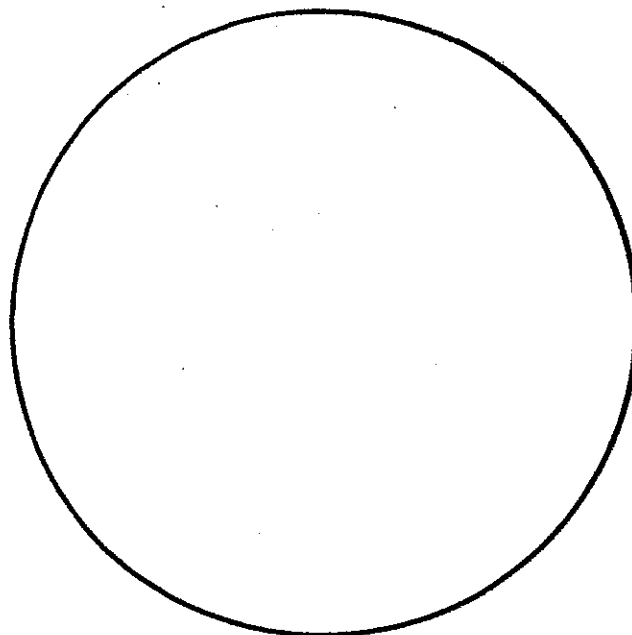
metric ruler
scissors

Procedure

Part A. Skeletal Muscle, Microscopic View

Skeletal muscle is attached to your skeleton. It makes up the bulk of your body weight.

- Examine a prepared slide of skeletal muscle under the microscope. Use low and high powers.
- Note the many nuclei (dark, round bodies) present. Also note that muscle tissue is made up of long strands or fibers. Each fiber shows a striped pattern resulting from alternating bands of light and dark protein fibers.
- Diagram skeletal muscle under high power in the space provided. Label *muscle fiber* and *nucleus*.



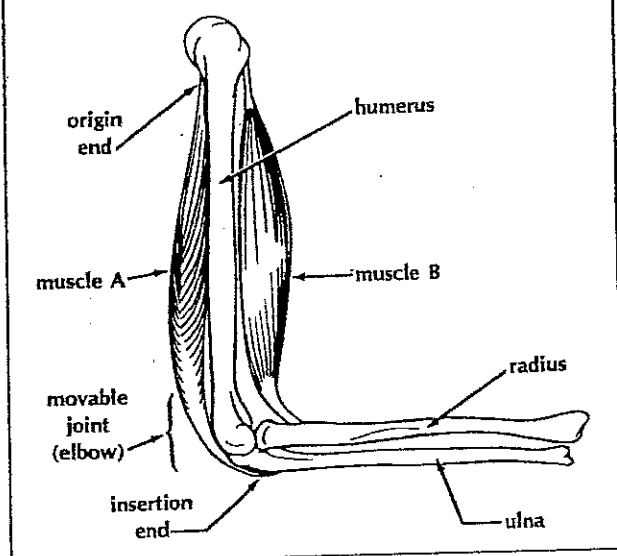
skeletal muscle

Part B. Muscle Contraction and Body Movement

Skeletal muscle does its job of moving bones or body parts by shortening its length. Biologists call this shortening contraction. As muscle contracts, it pulls bones or body parts into different positions. The muscles are attached to bones at

two different places. During contraction, one end of the muscle and what it is attached to do not move. The other end of the muscle and what it is attached to move when the muscle contracts. When not contracting, muscle is said to be relaxing.

FIGURE 71-1



• Examine Figure 71-1. It shows how the muscles of your upper arm are attached to your lower arm. The top end of one muscle (marked A) is attached to the middle of a nonmovable portion of the upper arm bone (humerus). This muscle end is called the point of origin. The muscle stretches over the elbow and is attached to the end of the lower arm bone (ulna). This muscle end is called the point of insertion. As the muscle shortens or contracts, the ulna is pulled down.

Figure 71-2 shows how the arm looks as muscle A contracts. Note that as a skeletal muscle shortens, it tends to bulge out.

Figure 71-3 shows a second arm muscle marked B.

• Label its point of origin.

• Label its point of insertion.

• Use Figure 71-3 to predict the location of the lower arm when muscle B contracts. Complete the diagram by drawing over the proper dashed lines to correctly show the new lower arm position.

1. How does muscle B change in shape as it contracts? _____

2. (a) Measure the length of muscle B in Figure 71-2. Record its length in millimeters

here. _____

(b) Measure the length of muscle B in Figure 71-3. Record its length in millimeters

here. _____

FIGURE 71-2

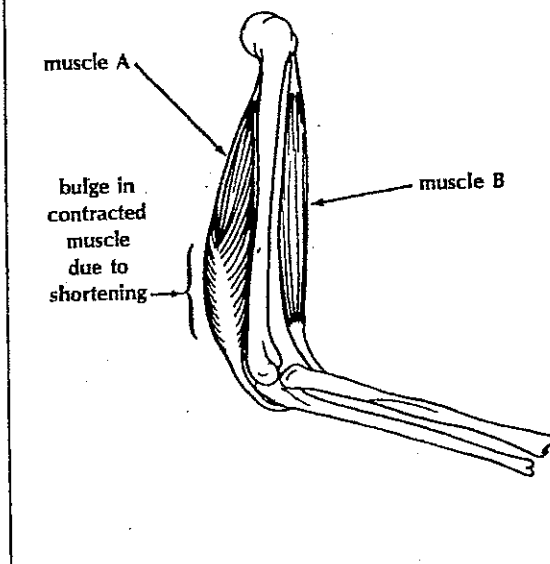
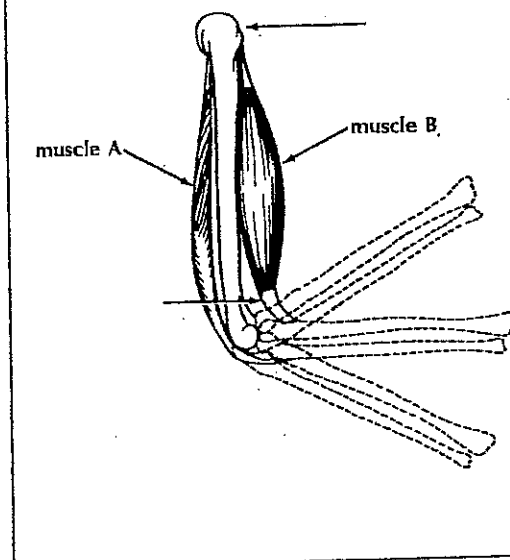


FIGURE 71-3



(c) How did the length of muscle B change as it contracted? _____

3. (a) Does muscle A move the lower arm up or down? _____

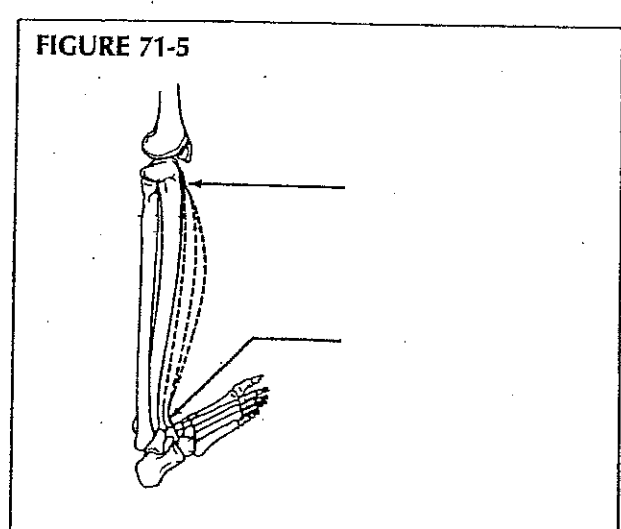
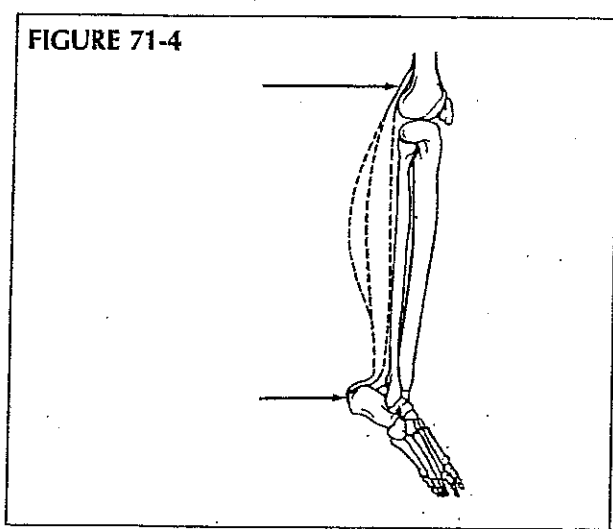
(b) Does muscle B move the lower arm up or down? _____

(c) How many different muscles are needed to move the lower arm up and down? _____

• Figure 71-4 shows one of the muscles needed to move your foot down. The muscle, however, is

Name _____

Date _____

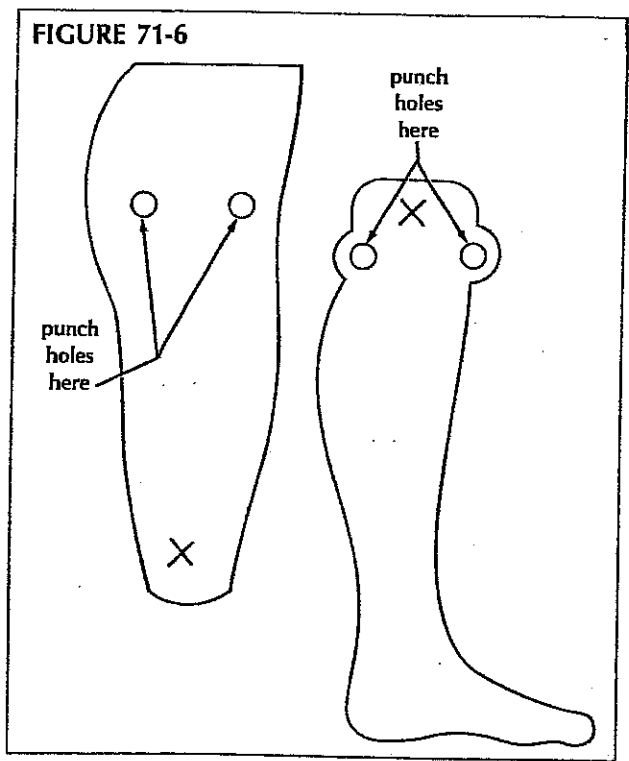


shown with only dashed lines. Label the *points of origin* and *insertion* of the muscle. Remember, the ankle is a movable joint.

- Complete Figure 71-4 by drawing over the correct muscle shape when the foot is pulled down.
- Figure 71-5 shows one of the muscles needed to move your foot up. The muscle again is shown with dashed lines. Complete Figure 71-5 by drawing over the correct muscle shape when the foot is pulled up. Label the *points of origin* and *insertion* of this muscle.

- Trace Figure 71-6 onto a piece of paper.
- Cut out your traced figures and use them as a pattern for outlining the figures onto heavy paper (posterboard). **CAUTION:** Always be careful with scissors.
- Cut out the figures and connect both model pieces by using a metal fastener.
- Push the fastener through at the points marked with an X.
- Punch holes where indicated on both pieces.

4. (a) In Figure 71-4, is movement of the foot down achieved when the muscle shown contracts or relaxes? _____
- (b) In Figure 71-5, is movement of the foot up achieved when the muscle shown contracts or relaxes? _____
5. (a) Can the same muscle move your foot both up and down? _____
- (b) How many different muscles does it appear to take to accomplish movement up and down? _____



Part C. Muscle Model

Scientists often use models to help illustrate a particular idea or concept. This part of the investigation will use a muscle-skeleton model to help illustrate the concepts from Part B.

FIGURE 71-7

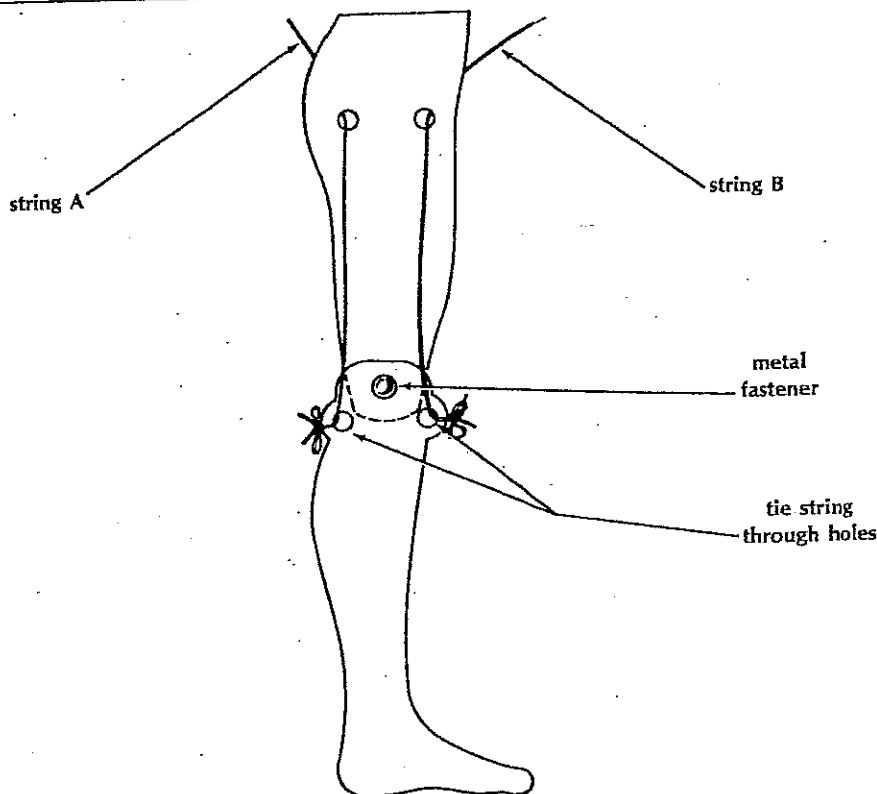


TABLE 71-1. MUSCLE MODEL SUMMARY

LEG POSITION	STRING TO BE PULLED?	LENGTH OF STRING IN MILLIMETERS		MUSCLE (STRING) RELAXED OR CONTRACTING?	
		A	B	A	B
Straight				—	—
Pulled forward					
Pulled backward					

• Add string to your model as shown in Figure 71-7. The strings represent the muscles present in your thigh.

• Position your leg model so that the foot appears flat as if the leg were standing on a flat surface.

• Measure the length of each string in millimeters and record these numbers in Table 71-1. NOTE: Measure only from where the string is tied in place to where it enters the top hole. Refer to the string on the left side as string A and the one on the right side as string B.

• Determine which string must be pulled in order to move the leg forward. Remeasure the strings while the leg is forward and record their lengths in the proper row of Table 71-1.

• Determine which string must be pulled in order to move the leg backward. Remeasure the strings while the leg is pulled back and record their lengths in the proper row of Table 71-1.

• Complete the last two columns of Table 71-1.

Name _____

Date _____

Analysis

1. Define the following terms:

(a) skeletal muscle _____

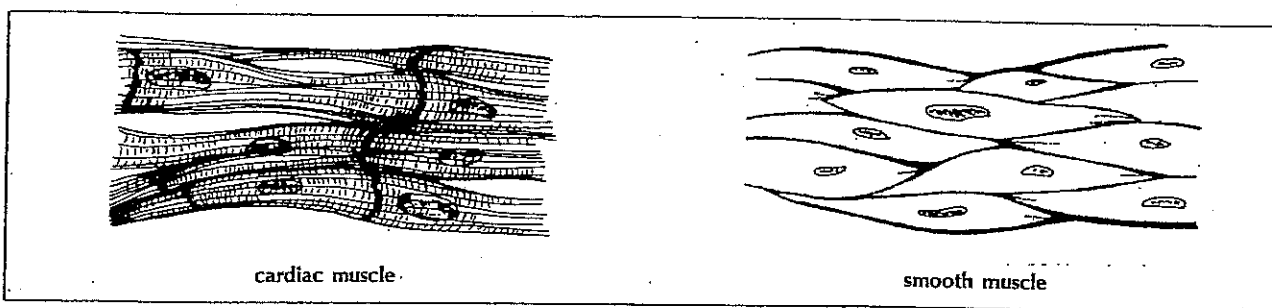
(b) contraction _____

(c) point of origin _____

(d) point of insertion _____

2. In Part A, you examined skeletal muscle. It is sometimes called striated muscle. Why is this name appropriate? _____

3. These two diagrams show two other muscle types present in your body. They are both drawn as they would appear under high power magnification.



(a) Use your text or other resources to determine where in your body cardiac and smooth muscle are found. _____

(b) Explain how cardiac muscle fibers differ from the fibers of skeletal muscle. _____

(c) Explain how smooth muscle differs from skeletal and cardiac muscle when comparing appearance of stripes. _____

4. Skeletal muscles are always found in pairs in your body. That is, one muscle moves a body part in one direction and a different muscle moves the same body part in an opposite direction. This pairing is referred to as antagonistic pairs.

(a) What is the meaning of the word antagonist? _____

(b) Were muscles A and B in Figures 71-2 and 71-3 antagonistic pairs? _____

Why? _____

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(c) Were the two muscles in Figures 71-4 and 71-5 an antagonistic pair? _____
Why? _____

5. Using Figures 71-2 and 71-3 again, describe the condition (contracted or relaxed) for:

(a) muscle A in 71-2 _____
muscle B in 71-2 _____

(b) muscle A in 71-3 _____
muscle B in 71-3 _____

(c) Describe how antagonistic muscles behave when a body part is moved in one direction and then in the opposite direction. _____

6. Using your model from Part C,

(a) explain what the two strings represent. _____

(b) explain what the metal fastener represents. _____

(c) explain the relationship between the two strings. (Were they antagonistic?) _____

(d) explain what pulling on each string actually represents. _____

7. Using your model from Part C,

(a) describe where the points of origin of those muscles which move your leg are located. _____

(b) describe where the points of insertion of those muscles which move your leg are located. _____

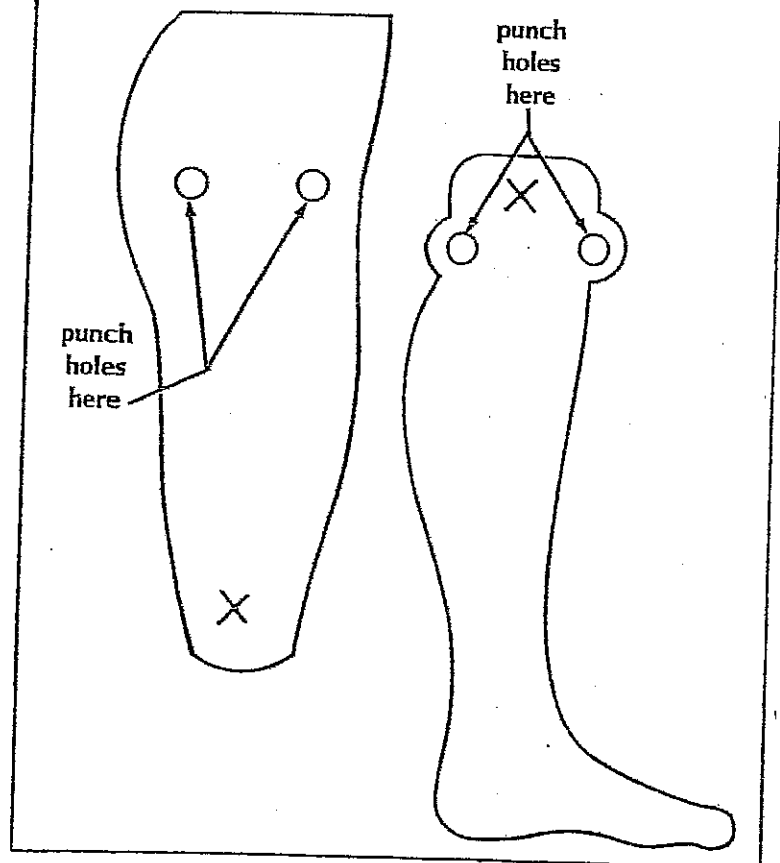
8. (a) In designing a marionette (puppet), how many strings would be needed to allow it to nod its head "no"? _____

turn its body toward the left or right? _____

(b) Could these strings be thought of as antagonistic muscles? _____

Explain. _____

FIGURE 71-6



Name: _____ Lab # _____

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Date: _____ Biology

What Causes Sports Injuries?

Introduction:

A number of different types of injuries can take place that involve the skeletal system or the muscular system. Many of these injuries result from everyday accidents, while others may occur while participating in certain sports. Some injuries affect the ligaments that hold the bones together or tendons that hold bones to muscle. In this lab, you will learn the difference between ligaments and tendons. You will also relate sprains, torn tendons and tendonitis to certain injuries.

Objectives:

- To learn the difference between ligaments and tendons
- To relate sprains, torn tendons, and tendonitis to certain injuries
- to learn the name of certain body muscles, bones and tendons

Materials:

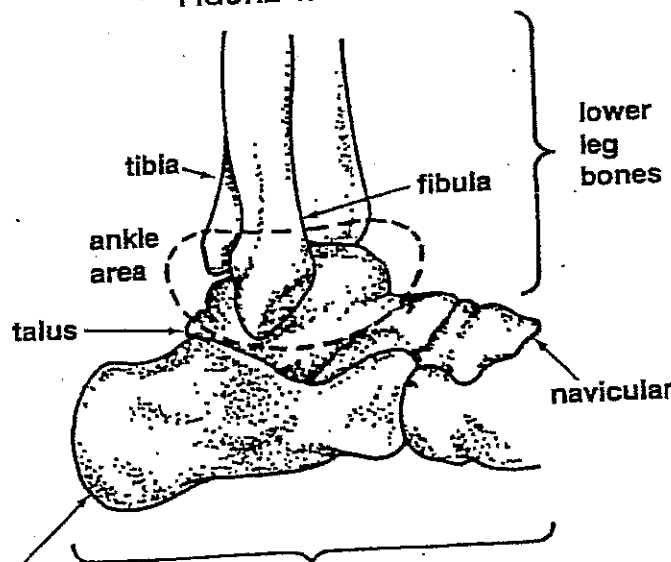
- pencil
- colored pencils or crayons

Procedure:

Part A - Sprains

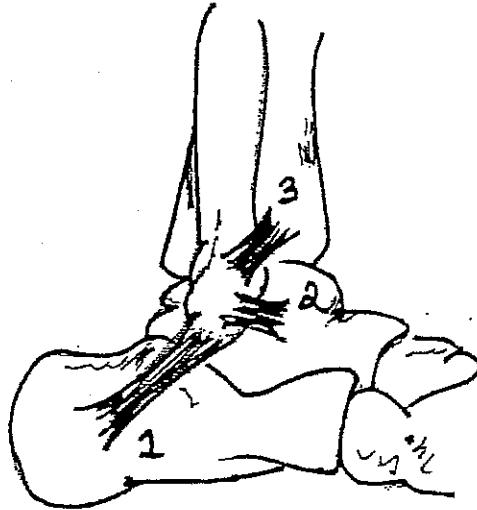
1. Examine figure 1. This is a drawing of the bones that are a part of the human ankle.

FIGURE 1. Bones of the ankle



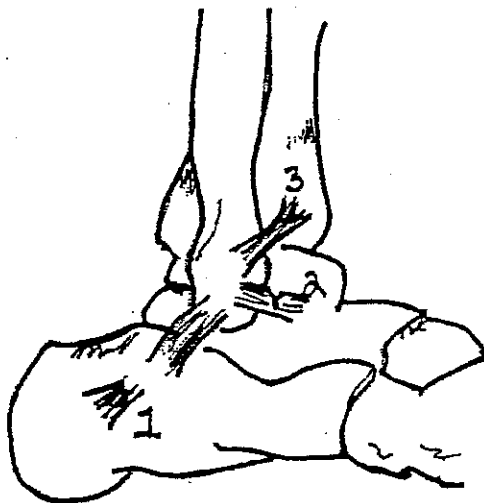
- 7
2. Examine figure 2. This is a similar drawing of the ankle, except that the three ligaments have been added. They are marked 1, 2, and 3.

Figure 2



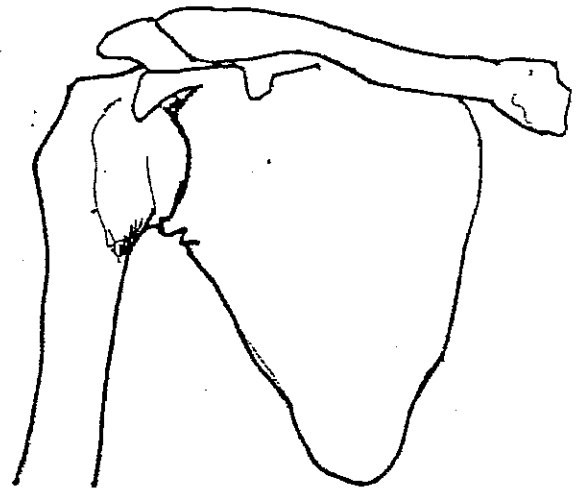
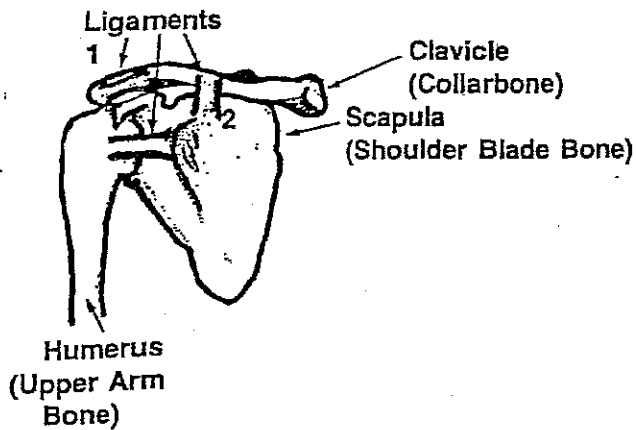
3. In figure 2, color all leg bones **grey** (or use a #2 pencil)
4. In figure 2, color all foot bones **blue**.
5. In figure 2, color all ligaments **red**.
6. Examine figure 3 showing the three types of sprains. They are:

Figure 3



First degree sprain: ligaments are only stretched
Second degree sprain: ligaments are only partly torn
Third degree sprain: ligaments are torn completely

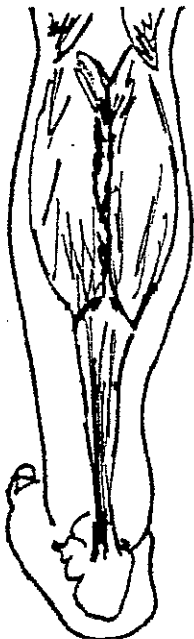
7. Examine figure 4 & 5. This is a drawing of the bones and ligaments of the shoulder.



8. Color all shoulder bones grey.
 9. Color all upper arm bones blue.
 10. Color all ligaments red.
11. Examine the incomplete drawing of the shoulder in figure 5. Finish the drawing by:
- drawing in a second-degree sprain of ligament 1.
 - drawing in a third-degree sprain of ligament 2.
 - drawing in a normal ligament holding the humerus to the scapula

Part B – Totally Torn Tendons & Tendonitis

1. Locate your calf muscle (your Gastrocnemius muscle.) Run your hand down your calf until you nearly reach the back of your heel. You should now be able to feel a thick cord at the back of your heel. This cord is a tendon (your Achilles tendon).
2. Examine figure 6a. This drawing shows an actual view of the back of the inside of a person's leg.



3. Finish figure 6b by showing what a totally torn Achilles tendon would look like.
Draw an arrow pointing to the torn area and label it.

4. Finish figure 6c by showing what tendonitis of the Achilles tendon would look like.
Tendonitis is a soreness of the tendon caused by small tears which occur along the tendon. Draw an arrow pointing to the tears and label them.

Conclusions:

1. What body parts are held together by ligaments? _____
2. Are ligaments a part of the muscular system or the skeletal system?

Why? _____

3. Look at figure 3
Which ligament shows a first degree sprain? _____
Which ligament shows a second degree sprain? _____
Which ligament shows a third degree sprain? _____

4. Which type of sprain probably takes the least time to heal? _____
5. Which type of sprain probably takes the most time to heal? _____

6. Look at figure 4.
Name the two bones held together by ligament 1. _____
Name the two bones held together by ligament 2. _____

7. Describe what one might have to do to cause a sprain.

8. Are tendons part of the muscular system or the skeletal system?

Why? _____

9. How do tendons differ from ligaments?

10. A totally torn tendon is a serious problem for an athlete or anyone else. A person will lose the use of the body part to which the tendon attaches. For example, a totally torn Achilles tendon will prevent a person from lowering his foot. Muscles shorten (contract) when they work. The Gastrocnemius contracts and pulls the foot down.

a) Explain why the foot cannot be pulled down if the Achilles tendon is totally torn

b) Might the foot be raised if the Achilles tendon is totally torn?

Why?

c) Might a person with a totally torn Achilles tendon still be able to move his leg?

Why?

Name _____

Period _____

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Before doing this lab, have students read sections 11-3-11:9 in the text.

Note: This lab can be done without the preserved animal heart being available for students.

11-1 How Does the Heart Work?

The heart is a muscular organ which pumps blood. It is divided into four chambers. The two upper chambers take in blood. The two lower chambers pump blood out of the heart. An upper chamber is called an atrium. A lower chamber is called a ventricle.

Blood moves only in one direction in the heart. Between each atrium and each ventricle there is a valve. The valve acts like a door that opens in only one direction.

Blood first moves into the two upper chambers. The top chambers then pump blood through the valves into the lower chambers. As the lower chambers fill with blood, the valves close. When the lower chambers squeeze together, the blood is forced out of the heart. Blood does not move back into the top chambers.

GOALS

In this exercise, you will:

- examine the outside and inside parts of a heart.
- trace the pathway of blood through the heart.
- follow the events within the heart as it pumps blood.

KEYWORDS

Define the following keywords:

atrium _____

contract _____

coronary artery _____

heart valves _____

ventricle _____

Pig or cow hearts can be used and are available from a biological supply house.

MATERIALS



sheep heart on paper towel or dissecting tray
colored pencils: red and blue

PROCEDURE

Part A. Parts of the Heart

- Obtain a sheep heart from your teacher. Do not turn it over. The right side of the sheep heart is on your left side. The left side of the heart is on your right side.*

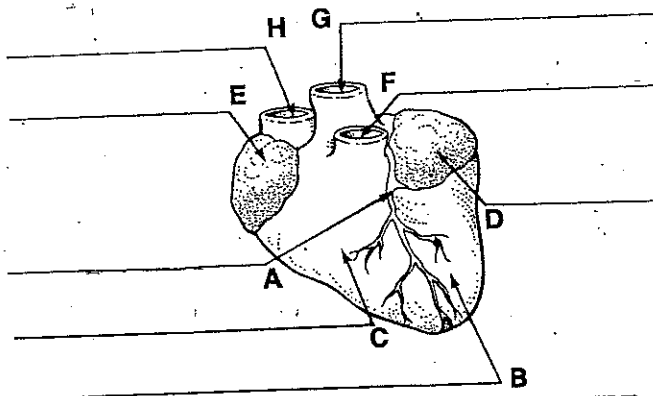


FIGURE 1.

*Suggestion: Label the left and right sides on the heart with a piece of paper and pin stuck through paper into the muscle. You as the teacher must position the heart correctly on the paper towel. The easiest way to tell the left from the right is that the coronary artery divides the heart in half. The left half will be wider.

2. On your sheep heart, find the parts listed in Table 1. Use the information in the table to help you.
3. Label the eight parts of the heart correctly on Figure 1. To help with the labels use the letters provided in the table and on the figure.

Table 1. Front Parts of the Heart

Part	Location	Traits	Name
A	across front of heart center	small blood vessel	coronary artery
B	bottom right chamber	large muscle section or chamber	left ventricle
C	bottom left chamber	large muscle section or chamber	right ventricle
D	top right chamber	small muscle section or chamber	left atrium
E	top left chamber	small muscle section or chamber	right atrium
F	top center	large blood vessel* from right ventricle	pulmonary artery
G	top center behind F	large blood vessel* from left ventricle; largest artery in body	aorta
H	top left	large blood vessel* from right atrium	vena cava

*All you will see is a hole where the blood vessel was attached to the heart.

Part B. Direction of Blood Flow Through the Heart

1. Examine Figure 2. It is a diagram of the inside of a heart. Arrows show the direction of blood flow.
2. Examine Figure 3 on the next page, which shows the inside of a sheep's heart. The arrows outlined in dashes indicate *possible* directions of blood flow. Using Figure 2 as a guide, fill in with a pencil the arrowheads that show the correct direction of blood flow.
3. Label the inside parts of this figure using Figure 2 as a guide.

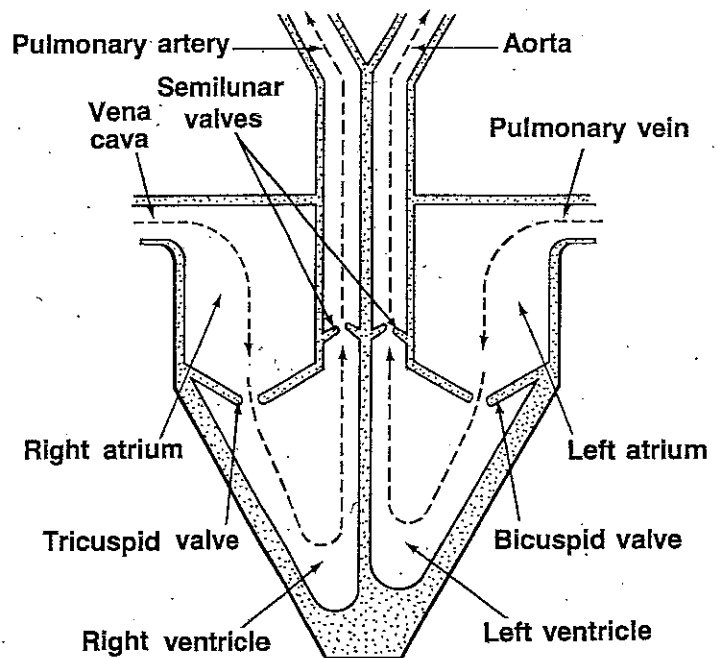


FIGURE 2. Blood flow through the heart

B = Blue
R = Red

Part C. Condition of Blood in the Heart

All blood on the heart's right side has little oxygen and much carbon dioxide. Blood on the left side has much oxygen and little carbon dioxide.

1. Using colored pencils, fill in the arrows in Figure 3 to show these differences in gas content:
 - a. all arrows that indicate blood with much oxygen should be colored red.
 - b. all arrows that indicate blood with much carbon dioxide should be colored blue.

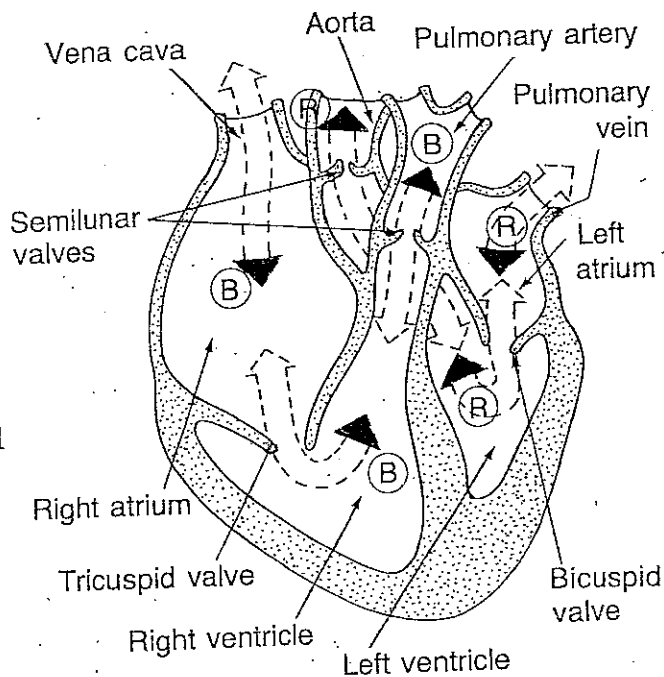


FIGURE 3. Inside of a sheep's heart

Part D. Pumping Action of the Heart

Blood enters the two top chambers of the heart. Because they are made of muscle, they are able to squeeze together or contract. When this happens, blood is pumped to the two bottom chambers which are relaxed. These events are shown in Figure 4.

1. Note that certain valves in Figure 4 are open while other valves are closed. Complete the first column of Table 2.
- Once blood fills the two bottom chambers they contract. Blood is then pumped out of the heart into the rest of the body. These events are shown in Figure 5.
2. Note which valves are open or closed in Figure 5. Complete the second column of Table 2.

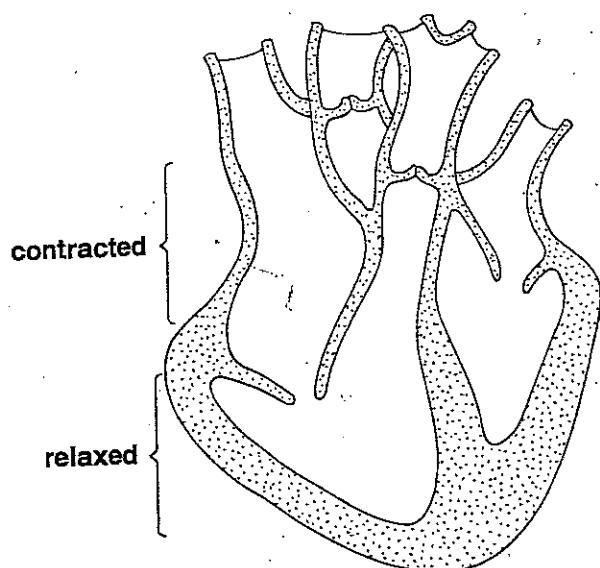


FIGURE 4. Blood entering ventricles

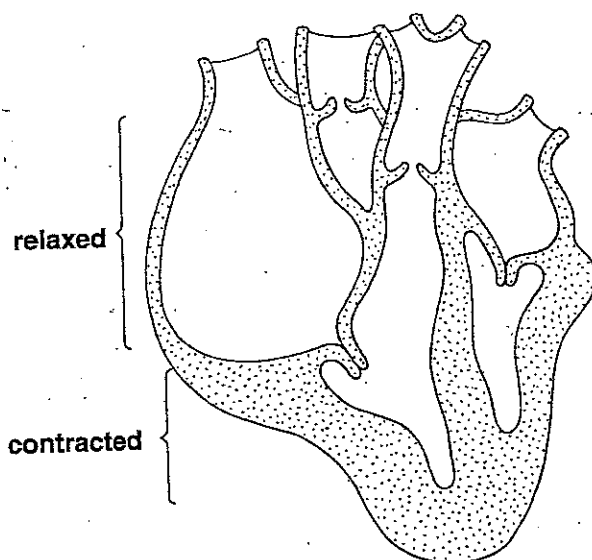


FIGURE 5. Blood leaving ventricles

Table 2. The Opening and Closing of Parts of the Heart

	Blood entering ventricles	Blood leaving ventricles
Top chambers (atria) relaxed or contracted?		
Bottom chambers (ventricles) relaxed or contracted?		
Semilunar valves open or closed?		
Bicuspid valve open or closed?		
Tricuspid valve open or closed?		

QUESTIONS

- What is the job of the coronary artery?_____
- Blood is pumped from the heart to the body through the aorta.
 - Which chamber does this job?_____
 - Does this blood have more oxygen or more carbon dioxide?_____
 - Which valves are open during this process?_____
- Blood is pumped from the heart to the lungs through the pulmonary artery.
 - Which heart chamber does this job?_____
 - Does this blood have more oxygen or more carbon dioxide? more carbon dioxide
 - Which valves are open during this process?_____
- Trace a drop of blood through the heart by putting these heart chambers and valves in proper order: left atrium, semilunar valve, right atrium, right ventricle, bicuspid valve, tricuspid valve, left ventricle, semilunar valve.
Begin with the right atrium. _____
- Using colored pencils, indicate if each heart chamber listed in question 4 contains blood with more oxygen (red pencil) or more carbon dioxide (blue pencil).
Underline each part in your answer to question 4 with the proper color.

12-2 What Blood Types Can Be Mixed?

Sometimes patients may lose a lot of blood. In these cases blood from another person can be given to the patient. This giving of someone else's blood to a person is called a transfusion.

There are four main blood types: A, B, AB, and O. Only certain blood types can be mixed when a transfusion is made. Mixing blood types incorrectly during a transfusion can lead to serious illness or the death of a patient.

GOALS

In this exercise, you will:

- set up plastic cups filled with water and food coloring to represent the four blood types.
- mix "blood" to see if color changes take place.
- judge which blood types can be mixed safely.

KEYWORDS

Define the following keywords:

blood type _____

donor _____

recipient _____

MATERIALS

colored pencils: red, green, and black
food coloring: red and green
graduated cylinder

20 small clear plastic cups
6 droppers

PROCEDURE

Part A. Set Up

- Turn over the page and examine the grid in Figure 2. Note the columns marked *Recipient* and the rows marked *Donor*.
- Place one of the small plastic cups onto each of the 20 squares as shown here in Figure 1.
- Fill each cup with 10 mL of water.
- Using a dropper, add 4 drops of red food coloring to each of the four cups in the column marked *Recipient A* (red), and to the cup marked *Donor A*.

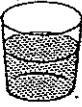



















Donor	Recipient			
	A	B	AB	O
				
				
				
				

FIGURE 1.

QUESTIONS

1. What is the function of
 - a. red blood cells? _____
 - b. white blood cells? _____
 - c. platelets? _____
2. How many
 - a. red blood cells are in a drop of normal blood? _____
 - b. white blood cells are in a drop of normal blood? _____
 - c. platelets are in a drop of normal blood? _____
3. Rank your answers given to question 2 as to the most common (1) to the least common (3). _____
4. Do your rankings for normal blood in Table 1 agree with your answer to question 3? _____
5. Explain why a person with anemia always feels tired (keep in mind the main job of red blood cells). _____

6. The rank of blood cells in a normal person and one with polycythemia is the same. How can you conclude that the person has polycythemia? _____

7. The rank of blood cells in a normal person and one with sickle-cell anemia is the same. How can you conclude that the person has sickle-cell anemia? _____

8. Name a blood disease that shows
 - a. too many white blood cells _____
 - b. too few platelets _____
 - c. too few red blood cells _____
 - d. too many red blood cells _____
9. Explain why a person with thrombocytopenia purpurea shows many bruises or purple marks. _____

10. Explain how the counting and appearance of blood cells can help in the diagnosis of blood diseases. _____

5. Using a different dropper, add 2 drops of green food coloring to the four cups in the column marked *Recipient B* (green), and to the cup marked *Donor B*.
6. Add 3 drops of red food coloring and 3 drops of green food coloring to each of the four cups in the column marked *Recipient AB* (red and green), and to the cup marked *Donor AB*.
7. Note that the four cups in the column marked *Recipient O*, and the one cup marked *Donor O* have no food coloring added to them.
8. Using colored pencils, color in Table 1 to show the colors of all 16 cups marked *Recipient*.

Table 1. Before Blood Is Mixed

Donor	Recipient			
	A	B	AB	O
A				
B				
AB				
O				

Part B. Mixing Blood Types

1. Using a clean dropper, remove "blood" from the cup marked *Donor A*. Moving across the grid, add 2 droppers full of Type A "blood" to each of the four cups in the same row. This step shows what happens when a donor gives his or her blood to a recipient.
2. Repeat step 1 for the next row, but this time use "blood" from the cup marked *Donor B*.
3. Repeat step 1 for the next row, but this time use "blood" from the cup marked *Donor AB*.
4. Repeat step 1 for the final row, but this time use "blood" from the cup marked *Donor O*.
5. Color in Table 2 to show the colors of all 16 recipient cups.

Table 2. After Blood Is Mixed

Donor	Recipient			
	A	B	AB	O
A				
B				
AB				
O				

Name _____ Class _____ Period _____

FIGURE 2. Grid for mixing food colors

Donor	Recipient			
	A	B	AB	O
A (red)	(red)	(green)	(red + green)	(clear)
B (green)	(red)	(green)	(red + green)	(clear)
AB (red + green)	(red)	(green)	(red + green)	(clear)
O (clear)	(red)	(green)	(red + green)	(clear)

Part C. Judging If Blood Is Safe to Mix

1. Compare Tables 1 and 2. Blood is *safe* to mix between donor and recipient if there is *no change in color* in the same cup from Table 1 to Table 2. Blood is *not safe* to mix between donor and recipient if there is *a change in color* in the same cup from Table 1 to Table 2.
2. Complete Table 3. Write the word *safe* or *unsafe* in each of the 16 squares.

Table 3. Is Blood Safe To Mix?

Donor	Recipient			
	A	B	AB	O
A				
B				
AB				
O				

QUESTIONS

1. List the blood types of people to which a Type A donor can safely donate blood. _____
2. List the blood types of people to which a Type B donor can safely donate blood. _____
3. List the blood types of people to which a Type AB donor can safely donate blood. _____
4. List the blood types of people to which a Type O donor can safely donate blood. _____
5. A person with Type O blood is often called a "universal donor." Why might this be a good term to use to describe such a person? _____

6. A person with Type AB blood is often called a "universal recipient." Why might this be a good term to use to describe such a person? _____
























Name _____ Class _____ Period _____

12-C Blood Types*In your textbook, read about blood types (Sections 12:9 and 12:10).*

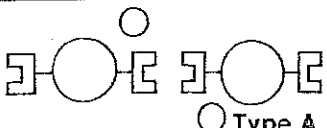

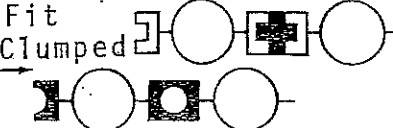
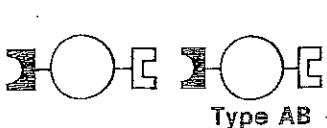
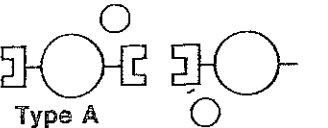
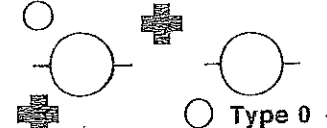
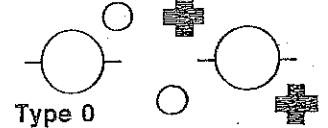
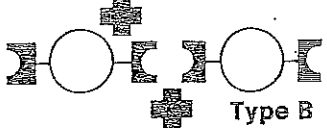

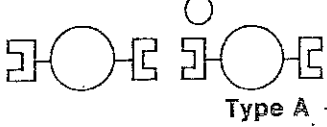
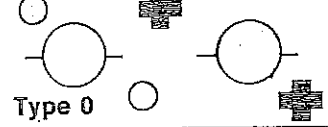
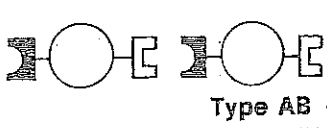
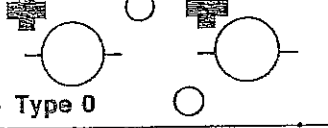
1. Examine Figure 12-15 in your text. Then complete this table by using checkmarks.

	Type A	Type B	Type AB	Type O
Plasma proteins of type A blood do not fit which red cell proteins?				
Plasma proteins of type B blood do not fit which red cell proteins?				
Plasma proteins of type O blood do not fit which red cell proteins?				
Red blood cell proteins of type A blood do fit which plasma proteins?				
Red blood cell proteins of type B blood do fit which plasma proteins?				
Red blood cell proteins of type AB blood do fit which plasma proteins?				

2. Show how the following blood cell proteins and plasma proteins do or do not fit by completing the drawings. The first one is done for you. Complete the last column by writing "yes" if the fit could cause blood to clump. Write "no" if the fit could cause no clumping.

RED BLOOD CELL PROTEIN AND TYPE	PLASMA PROTEIN AND TYPE	FIT OR NO FIT DRAWING	BLOOD COULD CLUMP?
		  (no fit)	No
			
 			
 	 		
	 		
			
	 		
			

3. Complete the chart below by drawing in the pictures that go in the column marked "fit resulting in clumps." Mark in the last column if it is safe or unsafe to mix these blood types. The first one is done for you as an example.

BLOOD TYPE	MIXED WITH	BLOOD TYPE	FIT RESULTING IN CLUMPING OR NO FIT	SAFE OR UNSAFE?
 Type A + Type B			Fit Clumped 	Unsafe
			→	
			→	
			→	
				
				

12-D The Immune System

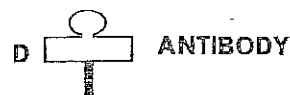
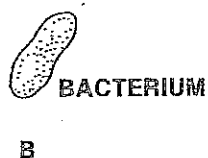
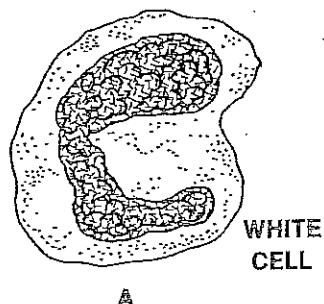
In your textbook, read about the immune system (Sections 12:11 and 12:12).

1. Describe where each part of the immune system is located and write the correct function for the immune system parts listed in the table.

Immune system part	Location in body	Immune system function
bone marrow		
spleen		
thymus gland		
lymph vessels and fluid		
lymph nodes		

Name _____ Class _____ Period _____

2. a. Define immune system. _____
 - b. Define antigen. _____
 - c. Define antibody. _____
3. Figures A, B, C, and D are labeled for you. You are to:
 - a. draw the antigen onto the correct cell that normally has antigens on it.
 - b. draw the antibody onto the correct cell that normally has antibodies on it.



4. Using the drawing of the white cell, bacterium, antigen, and antibody as a guide, make a drawing in this space that shows how the white cell and bacterium will join together because of their properly fitting antigen and antibody. Label all four parts.

5. Explain why or how:
 - a. your skin, tears, and mucus can be part of your immune system.

b. a bacterium with antibodies stuck to it will be destroyed.

c. memory white blood cells are helpful.

Due Date _____

Blood Disorders

Blood is a complex fluid tissue composed of liquid plasma and different cells with different jobs. If a blood smear is observed under the microscope, three different cell types will be observed - red blood cells, white blood cells, and platelets. In a sample of normal blood, the numbers of blood cells are fairly constant. Sometimes, however, the number of cells will change due to a particular disease condition. Noticing this change in number can help a physician in the diagnosis of a blood disease.

The objectives of this investigation are to:

- 1) identify the differences between a normal blood sample and samples of blood from individuals with iron deficiency anemia, leukemia, polycythemia, and thrombocytopenia.

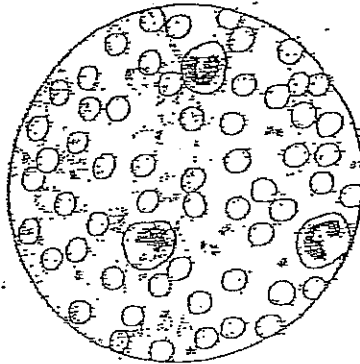
MATERIALS

pencil

PROCEDUREPART A - Normal Blood Smear

- 1) Examine Figure 1, which shows human blood cells magnified 1000 times.
- 2) Count each cell type present. To help avoid counting cells, twice, it might help to put a check mark on each cell as it is counted. Use the following information as a guideline:
 - a. *red blood cells* - round, very numerous, no nucleus.
 - b. *white blood cells* - round, few in number, larger than red cells, nucleus present.
 - c. *platelets* - dotlike cell fragments, fewer in number than red cells, but greater than white, extremely small.
- 3) Record the number of each cell type for Figure 1 in the Analysis table in the first column. Using the numbers 1, 2, and 3, rank the cells in order from most numerous (1) to at least numerous (3). Enter these rankings in the next column in the table marked *rank*.

Figure 1.
Normal Blood Sample



PART B - Examining
Abnormal Blood Smears

- 1) Examine figures 2 to 6. These figures represent human blood samples from people with certain diseases.
- 2) Count each cell type and record the number for each sample in the Analysis table in the proper column.
- 3) Complete the rank columns using the numbers 1 to 3, as done with the normal blood smear.

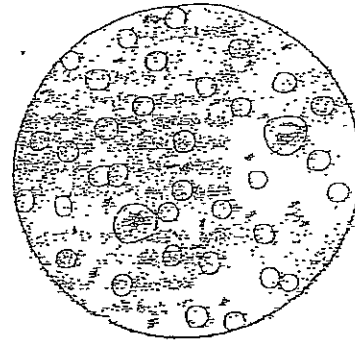


Figure 2

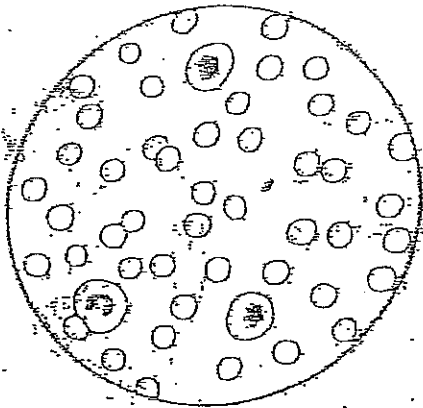


figure 3

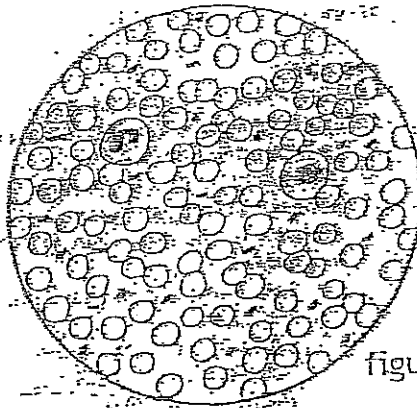
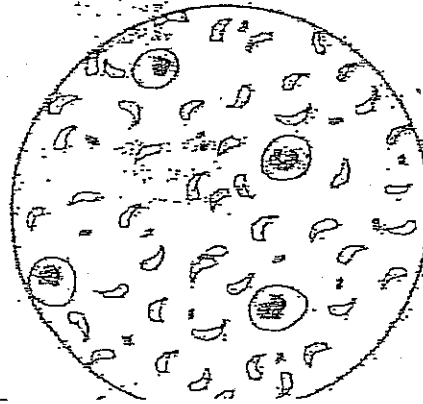
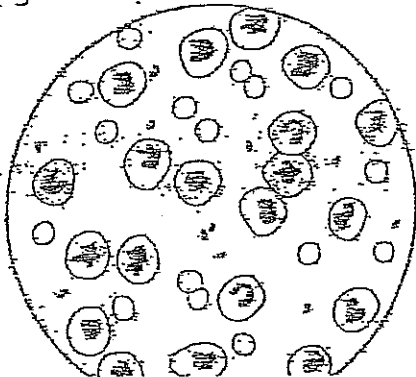


figure 4



PART C - Diagnosing Blood Diseases

- RT C - Diagnosing Blood Diseases
- Read over the following case histories for five hospital patients. (Figures 2-6)
 - Match each case history with the appropriate blood sample.
 - Record the name of each disease ("Disease diagnosis) in the correct column of the Analysis table.

CASE HISTORY: female, black, age 18; has poor nutrition, complains of always being tired and having no energy.

Blood analysis: Red blood cells - low in number, a few with unusual shape
Blood cell rank - red= 1, platelets= 2, white= 3

Disease diagnosis: Iron deficiency anemia (an = no, emia = blood)

CASE HISTORY: male, black, age 15; is always tired and short of breath.
Blood analysis: Red blood cells shaped like crescent moons.
Disease diagnosis: Sick cell anemia

CASE HISTORY: female, age 14; has a fever, sore throat, and frequent nosebleeds.

Blood analysis: Red blood cells - low in number, white blood cells - abnormally high in number; Blood cell rank - white = 1, Red = 2, platelets = 3.

Disease diagnosis: Leukemia (form of cancer) (*leuk* = white, *emia* = blood)

CASE HISTORY: male, white, age 68; has frequent headaches, nosebleeds, has high blood pressure and a very red complexion.

Blood analysis: Red blood cells - a very high number

Disease diagnosis: Polycythemia (*poly* = many, *cyth* = cell, *emia* = blood)

CASE HISTORY: female, age 22; has sudden appearances of purple marks under the skin, bruises easily; blood does not clot easily after a cut.

Blood analysis: Platelets - very few in number

Disease diagnosis: Thrombocytopenia purpurea (*thrombo* = platelet, *cyto* = cell, *penia* = purple)

Analysis

Cell type	Fig. 1		Fig. 2		Fig. 3		Fig. 4		Fig. 5		Fig. 6	
	No.	Rank	No.	Rank	No.	Rank	No.	Rank	No.	Rank	No.	Rank
Red												
White												
Platelet												
Disseminated bleeding	Normal blood											

DISCUSSION QUESTIONS

- A. What is the function of:
1. red blood cells
 2. white blood cells
 3. platelets
- B. Blood cells do not last forever. They regularly wear out and need to be replaced. Where are new cells of each of the above types produced?
- C. In a drop of normal blood, which cells are most numerous? least numerous?
- D. Why is lack of a nucleus an advantage for red blood cells?
- E. Why does a person with anemia often feel tired and easily become short of breath?
- F. The rank and number of blood cells in a normal person and one with Sickle-cell anemia is almost identical. How then can a doctor conclude that a person has sickle-cell anemia?
- G. Two specific types of white blood cells are *phagocytes* and *lymphocytes*. Though their jobs are similar, they accomplish their objectives differently. How does the action of phagocytes differ from that of lymphocytes?
- H. How do platelets help the blood to clot?
- I. Why might a person with thrombocytopenia purpurea have many bruises or purple marks?

Name _____ Class _____ Period _____

28-2 How Can a Mutation in DNA Affect an Organism?

Sometimes the DNA code that makes up a gene has an error in it. This error is called a mutation. When the DNA contains an error, the mRNA it makes will copy that error. When the mRNA contains an error, it will code for incorrect tRNAs and produce an incorrect protein.

Sickle-cell anemia is a disorder that gets its name from the sickle shape of the red blood cells. The sickled red blood cells are caused by a mutation in the hemoglobin of the person with the disorder. Hemoglobin is the main protein in red blood cells. Each hemoglobin molecule carries oxygen from the lungs to all other parts of the body.

INTERPRETATION

OBJECTIVES

In this exercise, you will:

- examine the coding errors produced in mRNA and tRNA when there is a mutation in the DNA.
- examine the effect of a mutation in the gene that codes for blood hemoglobin.

KEYWORDS

Define the following keywords:

gene _____

hemoglobin _____

mutation _____

sickle-cell anemia _____

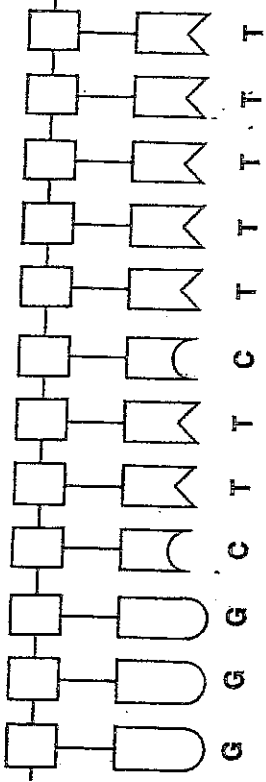
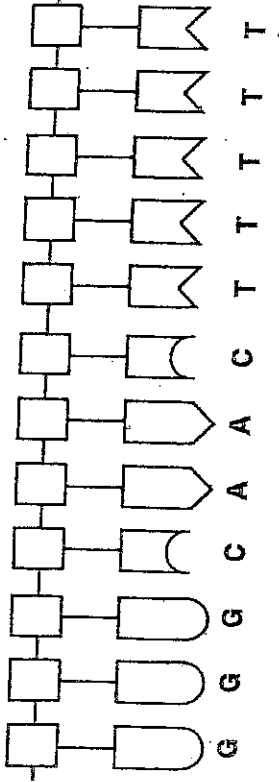
MATERIALS

colored pencil

PROCEDURE

- Examine Table 1. The two columns show a section of normal DNA and a section of DNA that has a mutation in it. The mutation is called *sickle hemoglobin*.

Table 1. Comparing Normal With Sickle Mutation DNA

	This section codes for normal hemoglobin	This section codes for "sickle" hemoglobin
DNA code		
mRNA code		
tRNA code		
Order of protein parts		
Shape of blood cells		

Name _____ Class _____ Period _____

2. In Table 1, in the row marked *mRNA code*, write in the correct letters that will match with the nitrogen base letters of DNA given in the row above. Do this for both columns. Remember that A matches with U, T matches with A, C matches with G, and G matches with C.
3. In the row marked *tRNA code*, write in the correct letters that will match with the nitrogen base letters of mRNA in the row above. Remember that A matches U, U matches with A, C matches with G, and G matches with C.
4. Examine Table 2. This table shows which protein parts are coded for by specific sets of nitrogen bases (three per set) of the mRNA molecule. For example, the mRNA sequence CCC codes for protein part A.

Table 2. Nitrogen Bases of Protein Parts

Protein part	mRNA
A	CCC
B	GAA
C	AAA
X	GUU

5. In Table 1, in the row marked *Order of protein Parts*, write in the correct order of protein parts coded for by the mRNA. Do this for both normal and sickle hemoglobin.
6. In the row marked *Shape of blood cells*, draw in what you think will be the correct shape of blood cells for the kind of protein found in the row above. Use the diagrams in Figure 1 for reference.

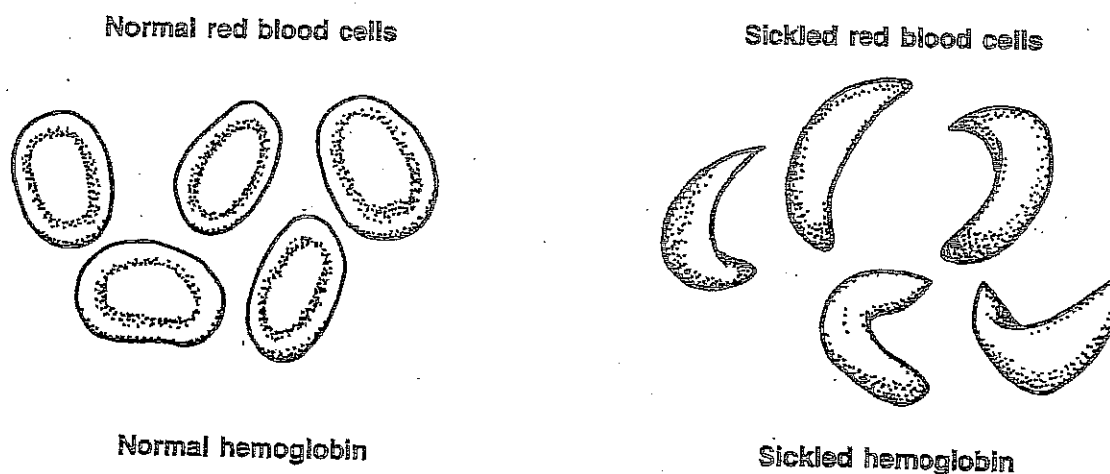


FIGURE 1. Shapes of blood cells

7. In the column marked *This section codes for sickle hemoglobin*, locate the two nitrogen bases that are different in DNA, mRNA, and tRNA from those in the column for normal hemoglobin. Color those bases that are mutations with the colored pencil.

0. 1. Look at the two DNA molecules in Table 1. What nitrogen bases in the sickle mutation DNA are different from those of the normal DNA?
-
2. If every three nitrogen bases on DNA represent a gene, how many genes are shown on
- a. the section of normal DNA? _____
 - b. the section of sickle hemoglobin DNA? _____
3. List the nitrogen bases (examined in Table 1) for
- a. the normal genes of hemoglobin _____
 - b. the sickle hemoglobin genes _____
4. How many genes are different in sickle hemoglobin DNA compared with normal hemoglobin DNA? _____
5. How many protein parts are different in sickle hemoglobin compared with normal hemoglobin? _____
6. How many genes are needed to code one protein part into a protein such as hemoglobin? _____
7. Define the word *mutation*
- a. by using the word "gene." _____

 - b. by using the phrase "DNA code." _____

8. It is possible to move genes from one molecule of DNA to another. A normal gene could be put in the place of a gene with a mutation.
- a. If the DNA with a mutation were corrected in this way, what would happen to the mRNA that DNA makes? _____

 - b. What would happen to the protein formed by this mRNA? _____
